

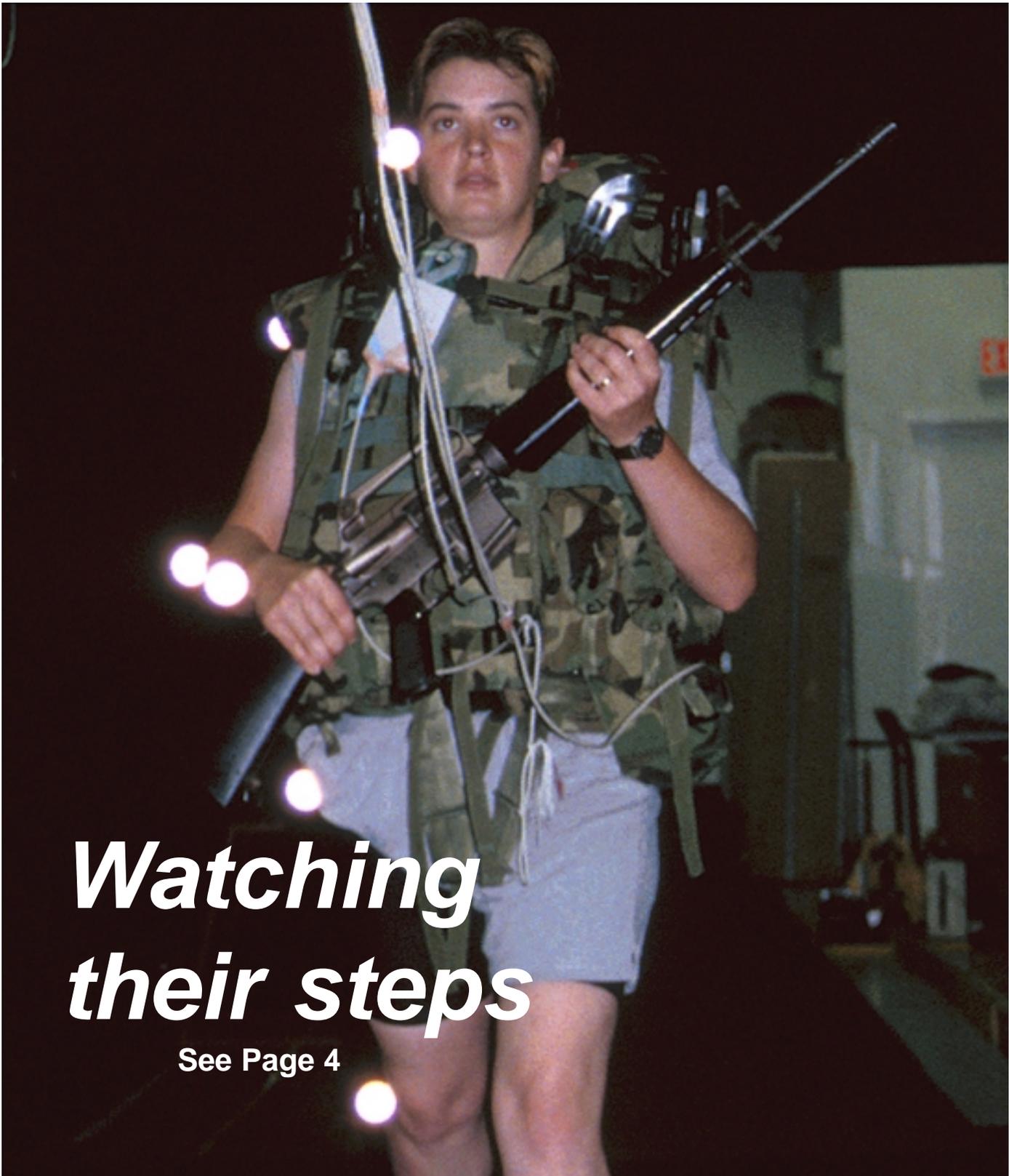


# THE WARRIOR

U.S. Army Soldier Systems Center

Natick, Massachusetts

September-October 2000



*Watching  
their steps*

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**Cover photo: A human research volunteer steps off the force platform at the biomechanics lab during a study of the MOLLE and ALICE rucksacks in 1999. The force platform measures the force pattern of a person's feet on the ground in the vertical, fore-aft and medial-lateral directions.(Courtesy photo)**



U.S. Army Soldier Systems Center

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# New deputy explains mission

As the new deputy for acquisition and readiness for the U.S. Army Soldier and Biological Chemical Command (SBCCOM) and commander of the Soldier Systems Center, I am looking forward to a myriad of new experiences. I am looking forward to leading such a highly regarded work force and presiding over our world-class facilities. As a Georgia native, I am also looking forward to my first New England fall and winter.

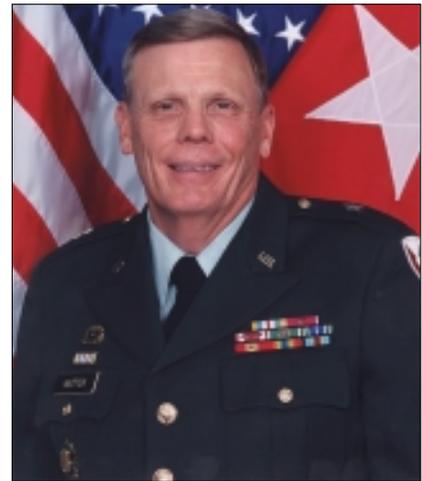
This mission of the Research, Development and Acquisition (RDA) Enterprise is to provide total life-cycle management for the research, development, acquisition, testing, systems integration, product improvement, fielding, and maintenance of the best soldier and chemical biological protective materiel. This means that we are responsible for products and innovations from start to finish, from research and development to logistics. The enterprise also provides products and services in the areas of chemical treaty verification and environmental remediation.

Our top-notch organization consists of our Research Development and Engineering Center, which is

composed of two premier entities: The Edgewood Chemical Biological Center and the Natick Soldier Center. The RDA Enterprise also includes Project Manager for NBC Defense Systems, Project Manager-Soldier Systems, Product Manager-Soldier Support, and the Integrated Materiel Management Center, which provides logistical support for the command and all its products and programs.

I also preside over the Soldier Systems Center. Although it has had many names over the years, the Soldier Systems Center has been synonymous with technological innovation and scientific ingenuity for almost 50 years. Over the years, several things have remained constant.

The first is our longstanding commitment to providing the highest quality and most scientifically advanced clothing, equipment, and air-drop technologies to our servicemen and women. We also remain committed to advancing food technologies that will not only best meet the needs of our service members and our nation's astronauts, but that will also ultimately benefit the civilian consumer as well.



**Brig. Gen. Philip M. Mattox**

Members of the work force of both the Soldier Systems Center and the RDA Enterprise are known for their integrity and their commitment to excellence. We recognize that we have not only a strategic imperative, but also a moral obligation to provide our troops with the highest quality food, clothing, and equipment to enhance their performance and their safety. By giving them our all, we enable our servicemen and women to give their all to serving this great nation.

Under my leadership, we will remain committed to providing robust logistical support to make sure the very latest innovations reach our service members intact and on time. Our organization will remain a vigilant environmental steward and will also work to build upon our great progress in acquisition reform to make sure we are doing business in the most efficient, productive and cost-effective way possible.

As an organization, we are adamantly committed to teamwork not only within the larger command but also in regard to partnering with academia, private industry and other government agencies. Our continued commitment to excellence, teamwork, and partnering will ensure that our products and technologies will continue to benefit not only the Army, but also the joint services and the civilian community well into the 21st century.

**Brig. Gen. Philip M. Mattox**

Brig. Gen. Philip M. Mattox assumed the position of deputy for acquisition and readiness for the U.S. Army Soldier and Biological Chemical Command July 21.

His previous assignment was director for Logistics, Engineering and Security Assistance (J-4), U.S. Pacific Command, Camp H.M. Smith, Hawaii.

Mattox graduated in 1970 with a Bachelor of Science degree in physical education from North Georgia College. Upon graduation, he received a Reserve commission as an armor officer through ROTC.

He has a master's degree in educational administration from Virginia State University. His military education includes the Armor Officer Basic Course, Armor Officer Advance Course, Command and General Staff College and Advanced Operational Studies Fellowship (Senior Service College).

Mattox has served in a variety of command and staff positions, including platoon leader and company executive officer, 4th Infantry Division; company commander, battalion S-4, 3rd Infantry Division; assistant pro-

fessor of military science, Virginia State University, Petersburg, Va.; assistant chief of staff for services, Chief Supply Management Division, 3rd Support Command; battalion executive officer, 19th Maintenance Battalion; commander, Division Materiel Management Center, 2nd Infantry Division; logistics staff officer, Pentagon; commander, 703rd Main Support Battalion and G-4, 3rd Infantry Division; seminar leader, School of Advanced Military Studies, Fort Leavenworth, Kan.; and commander, Division Support Command, 4th Infantry Division (Mech), Fort Carson, Colo. Mattox served as the III Corps assistant chief of staff, G-4, in Fort Hood, Texas, before reporting to the U.S. Pacific Command in June 1997.

Mattox's awards include the Defense Superior Service Medal; the Legion of Merit (with two Oak Leaf Clusters); the Meritorious Service Medal (with four Oak Leaf Clusters); the Army Commendation Medal (with three Oak Leaf Clusters); the Army Achievement Medal; the National Defense Service Medal (with Star); and the Army Staff Badge.

# Biomechanically-inclined

## Research facility finds ways to reduce physical stresses of soldiering

By Curt Biberdorf  
Editor

A full combat load for a light infantryman can weigh more than 100 pounds, rightly earning him the name “ground pounder.” How to increase the mobility of these laden soldiers and others while reducing injuries is

the main purpose of the Center for Military Biomechanics Research at the U.S. Army Soldier Systems Center (Natick).

Biomechanics research at Natick started in the mid-1980s at the U.S. Army Research Institute of Environmental Medicine (USARIEM), an installation partner of the Soldier

Systems Center, with studies on the effect of weight and speed, according to Dr. John Patton, chief of the Military Performance Division at USARIEM.

He said the research was minimal because space was inadequate. That changed dramatically in 1995 when the Natick Soldier Center—then called the Natick Research, Development and Engineering Center—joined USARIEM in opening the \$300,000 research center unique to the Department of Defense. The two organizations established a joint program in biomechanics and now share space, experimental equipment and scientific knowledge in a 7,500 square foot area formerly used as a storage room.

The Natick Soldier Center specializes in clothing and individual equipment while USARIEM focuses on the physical and medical components of biomechanics. Both aim at improving the ability of soldiers to do their jobs safely and effectively through the research tools of biomechanical research, and it seemed to be a good area to integrate Natick efforts, said Dr. Carolyn Benschel, research psychologist in the Supporting Science and Technology Directorate at the Natick Soldier Center.

### Reducing injuries

Biomechanics as a scientific discipline is the quantitative description of human movement (kinematics) combined with the analysis of the internal, external and twisting forces acting on the body (kinetics). In the course of their normal duties, soldiers are exposed to heavy forces on their musculoskeletal systems. The results of the forces are often inefficient performance or even injury.

“The overall thrust of our research is to decrease the incidence or risk of injury and enhance overall performance,” said Patton. “Injuries are the biggest medical problem. It’s estimated that 20-30 percent of men and 40-50 percent of women suffer from injuries. They result in lost duty



Courtesy photo

A research volunteer performs the depth jump onto a force platform during a prototype boot study.



Courtesy photo

**A video camera system for kinematics records and plots all body movements in 3-D.**

time and lower productivity.”

To conduct research, the laboratory uses an array of leading-edge testing equipment.

Since researchers need to visually record information to see what’s going on with the body during movement, a video camera system for kinematics records and plots all body movements in 3-D.

Furthermore, to measure muscle activity that can’t be captured visually, an electromyogram records electric signals from the muscles of test subjects performing various movements. The electromyogram, with a sampling frequency of 1000 cycles per second, quantifies muscle timing and activity level, and identifies power generating or absorbing muscles and fatigue effects.

“We use the electromyogram to figure what muscles are working,” said Peter Frykman, research physiologist at USARIEM. “It helps us understand movement patterns. In no time at all, we have a mountain of data. Then we find a way to boil down that data.”

Fully synchronized with the video cameras and electromyogram, a force platform recessed into the floor is used to measure the force patterns of soldiers’ feet on the ground in the vertical, fore-aft and medial-lateral directions. It’s extremely accurate for fast movements, with a sampling frequency of 1000 cycles per second.

Information from the platform is collected by a computer. Video cam-

eras capture body movements of soldiers carrying backpack loads and performing other military tasks. A computer processes the images frame-by-frame to determine the stresses on bones, muscles and body joints.

“Time synchronization with all the equipment is very important. It allows us to use measurements and find how they relate to each other,” Frykman said.

Tekscan Pressure Sensors are another tool used by researchers. A piece of flexible Mylar is filled with multiple pressure sensors. They measure peak and average pressure between two surfaces and map pressure distribution.

The system is used in an in-shoe force sensing system that determines the pressure distribution over the entire bottom of the foot to identify problems with footwear. The same system used with different sensors detects pressure distribution under backpack shoulder straps and hip pads.

The most common task for soldiers is basic manual materials handling, such as moving boxes of ammunition or artillery shells, according to Frykman. To study ways of

increasing efficiency, a section of the laboratory is used to simulate these military work tasks.

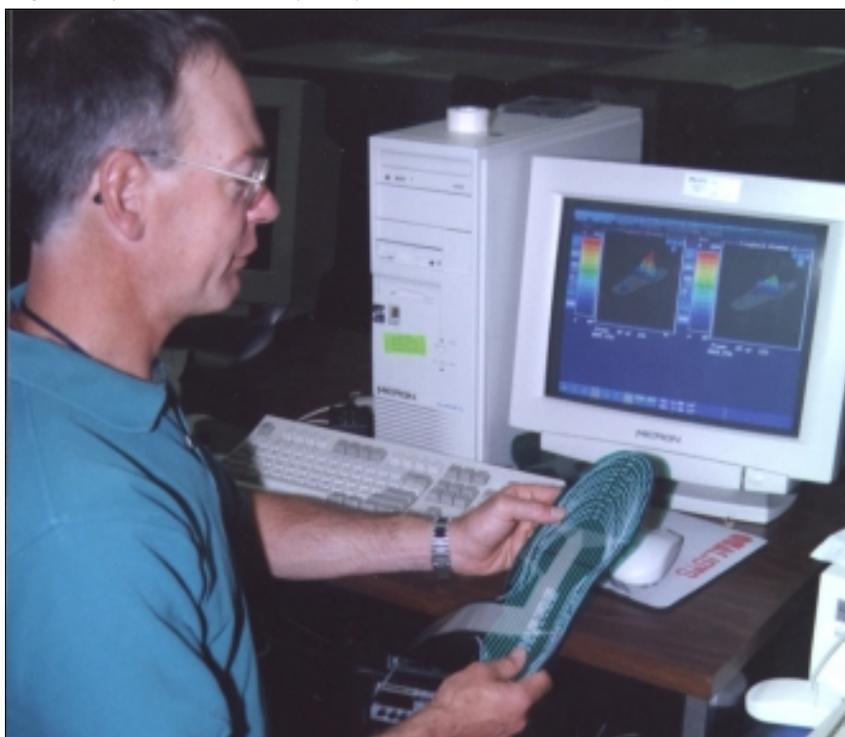
**Testing tasks**

Using specially yet simply designed equipment constructed mainly of wood, human research volunteers are tested to determine how much weight they can lift to various heights, how much they can lift repetitively, and their ability to lift and carry heavy loads. The work simulation equipment allows standards to be established for military jobs and enables assessment of physical training programs to determine if soldiers can significantly improve work performance.

“Simple task studies have a great deal of power and validity,” Frykman said.

The newest piece of equipment planned for the center is a treadmill that will allow researchers to measure forces in three axes at changing grades. The intention is to more accurately measure battlefield movement, Benseal said. It’s just one example of how the center is constantly looking for more tools and even building new tools to conduct

**Continued on Page 6**



Warrior/Biberdorf

**Peter Frykman, research physiologist at USARIEM, squeezes a Tekscan Pressure Sensor foot insert. Pressure intensity is visually displayed on the computer monitor.**



Courtesy photo

**A research volunteer climbs over a plywood wall in an obstacle course designed to evaluate the new MOLLE rucksack in 1999. An indoor course allows testing to be safely done under controlled conditions.**

research, added Frykman.

Studies using the equipment for biomechanical data are integrated into a three-part experimental approach. Besides biomechanics, physiologists determine metabolic efficiency by measuring oxygen consumption, and then test performance of common soldier physical tasks, such as crossing obstacles or firing a weapon.

What's learned from the studies is applied to needs such as personal equipment design and specific training programs for enhanced physical fitness. Certain jobs or tasks also may be modified.

One of the first major studies at the biomechanics lab involved evaluating a load carriage system for Land Warrior, the Army's effort to create a revolutionary weapons sys-

tem for the 21st century soldier.

When the Army was transitioning to the Modular Lightweight Load-carrying Equipment (MOLLE) rucksack, researchers tested it to ensure that soldiers could do their jobs better.

Another study showed that by shifting the center of mass in a standard military backpack, soldier performance changed by as much as 24 percent. Pack design and loading guidelines were influenced by the study.

"This is a classic example of work we can do here that's uncomplicated," Frykman said. "There are very few things that a commander can do to get that kind of result."

Patton said footwear companies have been using biomechanics laboratories for years to design shoes. The biomechanics research at Natick has spanned into evaluating a new combat boot design.

Several types of boots with better shock absorption were evaluated in the hope of finding a pair that works well and decreases lower extremity injuries, Bensel said. After measuring changes in gait, posture and force, several boots were



Courtesy photo

**A soldier drops her rucksack in evaluating the ease of doffing.**

eliminated from contention. Then the remaining boots were issued to troops for field evaluation.

“We used the lab to find the kind of boot that would reduce injury and then tested it to make sure it works in a real environment,” she said. “The results from real world testing are being analyzed, and a recommendation will be made from that data.”

### **Wide-ranging studies**

Besides boots and rucksacks, researchers have tested how cold weather clothing and body armor affected gait and range of motion.

“The tools of biomechanics are ideal for field clothing and personal equipment development because they identify which designs allow the body to move freely and impose the least amount of stress on bones and muscles,” Bensel said.

The biomechanics center is now involved in a five-year project to develop an optimal load-carriage system for enhanced warfighter performance. Load carriage expands beyond rucksacks.

“We want to look at the important variables in load carriage and use that information to design and develop equipment that improves

the performance of the soldier,” Bensel said. “Past studies tested specific equipment, but this program is directed toward understanding how the weight, dimensions and distribution of the load, and the distance the load is carried impact a soldier’s fitness-to-fight. This information is vital to designing equipment that is easier to carry so soldiers are combat-ready when they reach their destination.”

Frykman said there’s a myth that biomechanics will solve everything, but it is a powerful tool when used correctly.

Bensel added that soldiers using Natick’s clothing and equipment in the field can give researchers good feedback on what they like and dislike about an item, but biomechanical studies give researchers the underlying, quantitative information on how an item works together with the user.

That’s necessary in order to change designs and produce improved items.

“The thing that’s neat is that our research has a direct and immediate influence on soldiers,” Frykman said. “We get to see the impact of our work now.”



Courtesy photo

**Another item used in the obstacle course is the “overhead pipe,” which simulates crossing an open area. Studies sometimes involve simple props to test soldier agility.**



Courtesy photo

**A research volunteer performs the low crawl under a simulated barbed-wire obstacle wearing a rucksack.**

# More vegetables

## Variety of meatless entrees expanded in combat ration menu

By Jane Benson  
Staff Writer

Mothers of the nation's service members have a reason to rejoice: Not only are their sons and daughters eating their vegetables, they want more!

In response to their request, scientists at the Department of Defense Combat Feeding Program at the U.S. Army Soldier Systems Center (Natick) are working to include more vegetarian entrees on their Meals, Ready-to-Eat menu.

MREs are intended to feed warfighters in the field and on the move. They replaced the old C-Rations in the early 1980s. Since then, food technologists have continually updated and improved the menu offerings.

Their contents and packaging must be capable of surviving an airdrop and temperatures ranging from 60 below zero to 120 degrees F. In addition to freshness, nutritional and durability challenges, the meals must also taste good if they are to serve their purpose of feeding the warfighter to maximize performance.

Thus, the improvements to the meals have been largely fueled by the warfighters themselves, who fill out satisfaction surveys administered by the Operational Forces Interface Group, also part of the Soldier Systems Center.

After Operation Desert Storm, surveys indicated that the food preferences of the members of the Armed Forces closely resembled those of the general population. They wanted more ethnic foods and more vegetarian offerings.

"More and more soldiers are becoming health conscious, and even those who are not vegetarians enjoy an occasional meatless meal," said Judith Aylward, a registered dietician and a food technologist with the DoD Combat Feeding Program.

A case of 12 MREs now contains two vegetarian selections, which in the near future may increase to three. Soldiers now enjoy the following vegetarian entrees: pasta with vegetables in tomato sauce, cheese tortellini, pasta with vegetables in alfredo sauce, and black bean and rice burrito. The pasta with vegetables in tomato sauce was a hit with the Marines who first tested it.

"Some of the Marines who taste-tested the pasta and vegetable with tomato sauce offering said that eating the meal was like eating at the Olive Garden," said Aylward. "The perception that the warfighters only want meat and potatoes no longer holds true."

Aylward said that later this year, the program will be testing a vegetarian lasagna with carrots and spinach MRE. Other MRE vegetarian items for soldiers are being developed as well, including a vegetarian omelet with salsa and a vegetarian gumbo.

The changing tastes of service members are also reflected by the popularity of the miniature bottle of

Tabasco sauce that was added in 1993. Aylward said that ground red pepper packets and herbal seasoning packets will be introduced in 2002 to increase the variety of seasonings.

Although warfighters are becoming more health conscious, low-fat or low-calorie offerings are not feasible given the physical demands of their jobs. A soldier in the field needs about 3,600 calories a day. MREs typically contain 1,200-1,300 calories per meal, composed of 50 percent carbohydrates, 35 percent fat, and 15 percent protein.

MRE vegetarian meals do not contain any ingredients that are derived from animal or animal by-products. They also contain no alcohol products. In addition to the warfighters, other groups are interested in the vegetarian MREs.

"NASA, a long-time MRE customer, is interested in more vegetarian entrees as well. Astronauts are a very health conscious, elite group," Aylward said.

She said that the offerings also appeal to campers and outdoor sports enthusiasts, who order MREs from catalogs.

Aylward added that the Combat Feeding Program works closely with the Office of the Surgeon General to ensure high safety and nutritional standards for all meals, including vegetarian meals. The program also confers with the Armed Forces Chaplain's Board to meet the needs of those service members who have religious dietary restrictions.



Warrior/Underhill

**Cheese tortellini, pasta with vegetables in alfredo sauce, black bean and rice burrito, and pasta with vegetables in tomato sauce are four current vegetarian MRE selections.**

# Shedding light on Shade Room

**By Randy Lussier**  
Public Affairs Office

Something as apparently simple as uniform color shading can become a safety factor for soldiers. For instance, with Night Vision Goggles, the enemy can easily detect a soldier wearing a uniform without infrared protection.

Textile technologists at the U.S. Army Soldier Systems Center (Natick) Shade Room evaluate uniform materials for problems to ensure that the camouflage and shading provide soldiers minimum visibility and maximum protection.

The Shade Room's mission is visual and instrumental evaluation of color shades and instrumental evaluation of infrared properties. Natick is the official repository of all Army textile color standards and tolerances. The color of both current and new textiles, which consist mostly of uniforms, belts, tapes and tents, are continually evaluated.

"The biggest part of evaluating the shades is done by the naked eye," said Melanie King, a textile technologist in the Shade Room. "If a color appears flawed, then that particular shade will be immediately rejected."



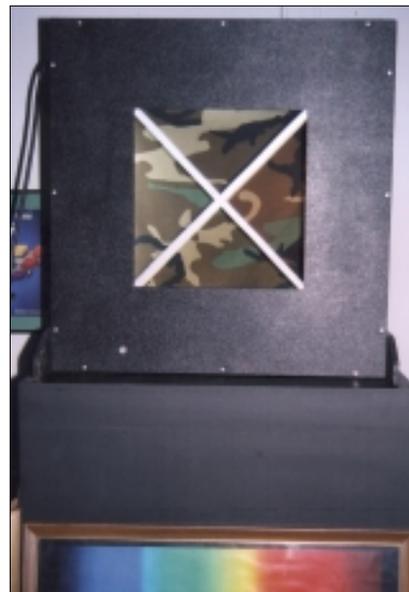
Warrior/Lussier

**Melanie King, textile technologist, stands in the Shade Room. The Shade Room's mission is visual and instrumental evaluation of color shades and instrumental evaluation of infrared properties. Natick is the official repository of all Army textile color standards and tolerances.**

Yet, it is the spectrophotometer that King said is a valuable tool in finding a precise indication of shade differences. It is used to measure color by testing the reflection of light off the sample and giving a wavelength measurement (every color has its own wavelength). The spectrophotometer also is able to measure near-infrared reflectance values, which are referenced in developing camouflage that blends with the environment when viewed with Night Vision Goggles.

Another form of color deviation is known as metamerism. Two or more samples that appear to be identical in color under a standardized light source will appear to change in different lighting. Various dyes and pigments are the culprits.

The American Society for Testing Materials, and the American Association of Textile Chemists and Colorists are professional organizations that establish testing methods used by the Shade Room. Materials are tested with lighting aimed at a 45-degree angle shining on a background also set at a 45-degree angle. The walls and table area must also be in the same shade of light gray. The desired effect is that of a clear,



Warrior/Lussier

**The light display shows how woodland camouflage appears different under incandescent, fluorescent and daytime lighting.**

sunny day at 3 p.m.

The Shade Room works closely with the Defense Supply Center Philadelphia (DSCP) in Philadelphia, Pa., to establish shade standards and acceptable parameters within each shade standard. DSCP purchases fabric and works directly with companies to evaluate contractor submissions from production contracts to ensure compliance with various physical standards, including color.

Over the years, hundreds of textile shade standards have been sent to DSCP for procurement. These standards are improved or replaced as necessary, and a master file of all standards and tolerances sent to DSCP is housed in the Shade Room for evaluation.

Standard samples and shade tolerance ranges are an integral part of shade acceptance and control in the military and industry, and they are used every day in the production and acceptance of multi-million dollar textile contracts for shade, appearance, and colorfastness, according to King.

Standards are continually being updated and replenished because of technology changes and improvements in dyes over the years.

# Blast protector

## Armor suit shields combat engineers from exploding mines

By Curt Biberdorf  
Editor

Combat engineers sweep, probe and detonate minefields at a surgeon's pace, and for good reason: A hidden munition can bring an explosive surprise.

However, engineers will soon have extra protection in case of unexpected detonation with the Body Armor Set, Individual Countermine (BASIC) system developed by Product Manager-Soldier Equipment at the U.S. Army Soldier Systems Center (Natick).

Landmines are inexpensive, easy to manufacture and plentiful, and soldiers can expect to encounter mines or improvised explosive devices in almost any scenario, said Capt. Greg Rawlings, combat developer at the U.S. Army Engineer School at Fort Leonard Wood, Mo.

"What you had was the thickness of (the Battle Dress Uniform) to protect you," Rawlings said. "One aspect of mine warfare is psychological. Their performance is based on their confidence, and this system will certainly help soldiers be at ease and go out there and do their mission."

In 1990, the BASIC technical requirements were established to reduce soldier injuries caused by the effects of blast and fragmentation antipersonnel mines. Within a few years, a suit was developed to support urgent operations in Somalia and Bosnia, said Barry Hauck, BASIC project director.

The system guarded the



Courtesy photo

**A combat engineer during training sweeps for landmines wearing the full Body Armor Set, Individual Countermine (BASIC) suit.**

lower extremities of troops against the M-14 blast mine, but the Engineer School needed more.

"They had a requirement to protect against bounding mines, which jump 1 meter from the ground before exploding, directional mines and the whole range of land mines that engineers may encounter," said Denise Tolliver, BASIC project engineer. "It took a while to study the engineers to see how they operate and then work with the clothing designers to come up

with an acceptable system."

"Our charter was to provide the engineers the best system available," Hauck said.

As with all ballistic protective systems, weight is a function of the protection provided to an anticipated threat, he said. Providing a high degree of protection while not incurring a significant weight penalty was a challenge throughout the BASIC development. A medium size suit weighs about 44 pounds, and although heavy, it

gives the best trade-off between protection levels and weight.

"It wasn't reasonable to cover the soldiers completely from head to toe, so the system was designed to cover critical areas while giving soldiers needed mobility," Hauck said.

New material technology has matured since the first operational assessment in 1999, and he anticipates as much as a 10-pound weight loss from the prototypes to the final production models without losing any performance.

Moreover, the modular design allows engineers flexibility during a deployment. Commanders can decide how much of the system is appropriate for the mission to reduce the weight burden.

"There are instances where the soldier or commander feels more comfortable in a different level of dress. It's the same idea as in a potential chemical environment," Rawlings said. "Walking in full body armor all day will wear you out."

Before the BASIC was developed, engineers wore the standard-issue armor vest and helmet for countermine operations.

The BASIC was designed to incorporate the helmet and either current armor vest or newly-introduced Interceptor Body Armor. The entire BASIC system is composed of another 10 components even though the entire system may not always be worn. Donning methods and sequence are an important element of the

BASIC suit, Tolliver said.

Dressing begins by fitting a cover made with a soft ballistic material over the helmet. Then a clear-lens plastic face shield with fastener is placed over the cover.

“A full-face shield is important because even a speck of dirt in the eye can slow a soldier down and further interrupt the mission,” Tolliver said.

Next is a black pair of boots that fit over the standard Army combat boots. The upper section is constructed with a nylon cloth and buckle fastener while the plastic sole is made with a wedge-shaped shank designed to deflect a blast away from the foot. An aluminum honeycomb in the sole absorbs shrapnel, and a layer of ballistic fiber absorbs the blast’s energy.

“It was a challenge to make good human factors because the boot doesn’t bend. It’s like walking in a ski boot,” Tolliver said.

The trousers are made of a layered ballistic soft fabric that protects the

front of the legs from the lower waist to the top of the feet. They were designed with extra emphasis on the shins and groin. They have adjustable elastic straps, Velcro fasteners and an articulated knee joint to allow soldiers to move unrestricted. A roll-up feature gives soldiers using one of the three sizes an opportunity to form a better fit.

For extra protection, a vest cover with extra plies of ballistic fibers is fitted over the armor vest. It overlaps the trouser waistband so that soldiers aren’t exposed when they bend down. An armor plate is inserted into a pouch built into the cover.

Soldiers also have arm protection. The upper arm is covered with a ballistic material shaped like the outer shell of football shoulder pads. They clip on to the vest cover and pivot to allow a soldier probing for mines freedom of movement. Lower arm protectors have elastic straps and Velcro fasteners for a good fit.

Two more pieces complete the system. An adjustable neck collar, designed for good mobility, gives heavy protection in front and tapers off toward the back. Finally, an armored groin plate is inserted into a holder that is fastened to the vest cover.

“The designers were in touch with the user community throughout the development to come up with a manageable, comfortable system,” Hauck said.

Every piece of the system can be easily removed

in case a soldier is injured, according to Tolliver. Its simplicity of dress and removal also allows soldiers to better transition from one task to another.

“If you were a victim of a mine, the outcome was bleak,” Rawlings said. “In case of a blast, you will still get hurt, but now we’re at the point where you can avoid being fatally injured.”

More than 7,000 of the BASIC systems will be issued to engineer units beginning in the middle of 2001.



Warrior/Biberdorf

Below the intact protective black boot is the side view of a boot sliced in half. An aluminum honeycomb in the sole absorbs shrapnel, and a layer of ballistic fiber absorbs the blast’s energy.



Warrior/Biberdorf

The entire BASIC system is composed of 10 components incorporated into the helmet and either current armor vest or newly-introduced Interceptor Body Armor. The other items are a helmet cover, face shield, collar, upper and lower arm protectors, vest cover, trousers, armor groin and chest plates, and protective overboots.

# Better barrier

*New toxicological agent protective suit raises user safety, comfort*

*By Curt Biberdorf  
Editor*

Better protection against toxic chemicals along with greater user comfort will be offered with the Improved Toxicological Agent Protective ensemble.

The ensemble, known as "ITAP," will replace the M3 Toxicological Agents Protective suit that was the military's standard protection for almost 40 years.

The state-of-the-art suit was developed by the U.S. Army Soldier and Biological Command under the management of Project Manager-Soldier at Fort Belvoir, Va., for Army Technical Escort Units and Chemical Activity/Depot personnel.

"The existing (M3) suit used old technology," said Matt Whipple, an engineer who worked on the ITAP. "We upgraded the existing materials and provided additional protection."

The Occupational Safety and Health Administration, and Environmental Protection Agency rate the ITAP at Level B protection, which is capable of providing up to one hour of skin and respiratory protection.

The ensemble will be employed during war or in peacetime in immediately dangerous to life and health toxic chemical environments, emergency life-saving response, incident response, routine chemical activity operations and initial entry monitoring. In cases that require Level A protection, the Self-contained Toxic Environment Protective Outfit (STEPO) is used.

"It's a splash suit. You don't need total encapsulation because the users don't expect to encounter vapors, although the new suit is sealed much better," Whipple said.

A one-piece suit, Self-Contained Breathing Apparatus (SCBA), Personal Ice Cooling System (PICS) and Compact Air Supply System (CASS) when a filtered mode is required, compose the ITAP ensemble.

One major improvement is the



Courtesy photo

**The Improved Toxicological Agent Protective suit is capable of being decontaminated at least five times after vapor or particulate contamination. After liquid contamination, the suit will be decontaminated and held for disposal.**

one-piece garment with integral boots, front fastener closure and glove assembly. It has a splash-proof zipper with closure in the upper portion of the body, a splash hood and an over vest to cover the breathing system.

"The TAP coveralls are merely that. They used duct tape to seal off the ankles and ends of the sleeves," said Larry Gossage, chief of the Chemical Support Division at Pine Bluff Chemical Activity, Ark.

The suit is a modified commercial item made of five alternating layers of Nomex and Teflon. The second layer of the encapsulating suit is orange, so the users can visually tell if the suit is deteriorating, said

Whipple. The material provides up to one hour of protection against chemical warfare agents, industrial chemicals, petroleum, oils and lubricants. It dissipates static charges, is self-extinguishing and flame-resistant, and its light-gray color reduces its solar load for improved user comfort.

The suit's impermeable material is desirable for protection, but it builds heat inside quickly. To increase operator comfort, all suits include the PICS.

The PICS removes heat from the user's body with a closed-loop cooling system that uses ice-cold water as a coolant. Water is circulated through tubing that runs throughout

the PICS cooling garment. The system provides about 30 minutes of cooling, depending on the air temperature and individual. The PICS consists of a pump unit, plastic bottle, connecting hose and tubing, suit pass-through and a shirt with tubing running throughout.

The PICS can be used longer if the ice bottle is changed periodically and can be switched in a contaminated environment. It's powered with three D-cell batteries and all together weighs about 15 pounds.

"We currently use a passive system," Gossage said. "Ice packs put into pockets of the suit are freezing cold at first. Then after 45 minutes, they've have lost their cooling and become dead weight. The PICS provides a consistent, continuous cooling."

The suit is modularly designed and can be configured in the CASS or SCBA mode to meet mission needs. M3 TAP gloves, M2A1 TAP boots and M40 mask are carried over from the old suit.

The SCBA is used when the suit is configured for Level B assignments. The apparatus is approved by the National Institute for Occupational Safety and Health and is used by Army and Air Force firefighters.

It consists of a 60-minute air cylinder, breathing valve, pressure gauge, connective hose and tubing, shoulder harness and waist belt. The SCBA is worn over the ITAP suit and weighs about 35 pounds. It will be used as an alternative to the CASS when a higher level of respiratory protection is required than is provided by a filtered air mode.

The CASS is a small, lightweight unit providing a continuous flow of clean, filtered air for breathing. The system is designed for use with the standard M40 mask used for Nuclear Biological Chemical respiratory protection. The Soldier and Biological Chemical Command developed the CASS blower unit for aviation use and adapted the technology for the ITAP suits. The

CASS filters air by maintaining positive pressure and airflow to the mask and suit.

"Two canisters provide airflow to the mask so that it's easier to breathe and supply a pressure to the suit so that in case of a small leak, the user won't be exposed to contamination," Whipple said. "In case the seal is broken in the suit or mask, outside air is not drawn in."

The ITAP suit uses a commercial communication system available with the SCBA. Whipple said that users talked to each other with hand signals or by speaking louder through their masks with the old system.

For Level B use, the ITAP is composed of a splash suit, splash hood, over vest, boots, gloves, breathing apparatus, a communication system and cooling system. For Level C protection, the splash suit, boots, gloves, M40 mask, CASS and PICS are worn.

Level B threats consist of liquids with moderate to high toxicity and vapors with high respiratory and low skin toxicity. The potential conditions in Level C are low to moderate toxicity with liquids and low respiratory and skin toxicity with vapors.

"Level B could be when there's a short-term cleanup of a leak, while in Level C we don't anticipate any exposure to chemicals," Gossage said. "For a longer cleanup or when the situation's more dangerous, we would use the STEPO."

Maintenance will be performed primarily at the user-level. The suit is capable of being decontaminated at least five times, two hours per use (or one hour under immediate danger to life and health conditions), after vapor or particulate contamination. After liquid contamination, the suit will be decontaminated and held for disposal.

Initial fielding may begin as early as 2001 and continue with a total of 4,000 suits issued by 2003, according to Frank Cole, logistics manager for ITAP at the Logistics Support Activity in Redstone Arsenal, Ala.

The goal is to have the ITAP suit available to complete the Congressionally-mandated chemical munitions stockpile destruction by 2007, said Marie Jean-Pierre, ITAP project engineer.



Courtesy photo

The ITAP suit is modularly designed and can be configured to different levels of protection.

# Value engineering cuts costs

By Kenneth Rice  
Contributing Writer

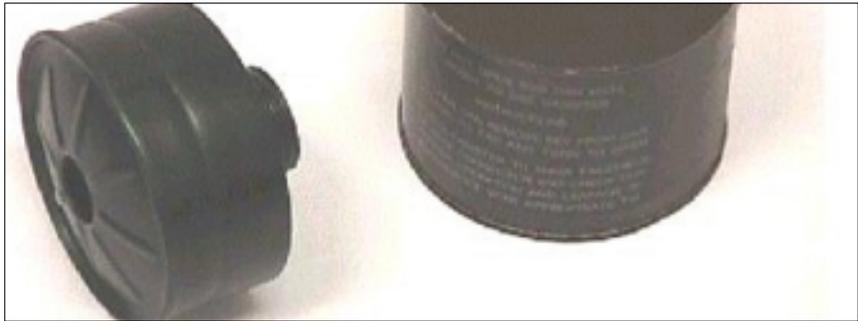
Experts from across the U.S. Army Soldier and Biological Chemical Command reviewed fielded items to develop cost-saving ideas during its first value engineering workshop June 5-9 in Edgewood, Md.

Participants from the Edgewood Chemical Biological Center (ECBC), Product Manager-Soldier Support, Product Manager-Nuclear Biological and Chemical Defense, Natick Soldier Center, Integrated Materiel Management Center (IMMC)-Rock Island, Ill., and Pine Bluff Arsenal, Ark., reviewed four items representing important aspects of each item's life cycle. They examined management, logistics, packaging and production (contractors).

Value engineering is a structured approach to reviewing a system, item or process that begins with a functional analysis, which is a review of what functions the item, system or process is required to perform. The analysis can determine if the item or process could be redesigned to perform these functions at a reduced cost.

Normally, the process evolves into narrowing the focus to the highest payoff functions with the best chance for success. This idea was the driver for the workshop. Value engineering has been receiving increased attention in the Army as it looks to reduce life cycle costs as a way to help fund modernization.

The teams looked at the required



Courtesy photo

**Modified packaging for the C2A1 canister could save as much as \$1.26 million.**

functions of the items, analyzing which functions were critical to their use, and choosing aspects of these items that would best benefit from cost-saving concepts. Each item posed individual challenges, and proposed solutions were as different as the items under study by the teams.

"This approach went well beyond the traditional value engineering mindset where contractors are encouraged to submit value engineering change proposals in hope that someday they might be implemented," said Michael Parker, SBCCOM deputy commander. "The conference took a very expansive view of value engineering considering everything in the life cycle."

Four items were reviewed.

## **M295 decontamination kit**

The M295 decontamination kit fits over the hand like a mitt and contains a decontamination powder pouch in the palm area. The kit is used for decontaminating field equipment that has been exposed to a

chemical agent attack.

Although the original design fully meets the requirements, it is expensive and labor-intensive to manufacture. A team representing Pine Bluff Arsenal (one of two M295 production facilities), the project officer from ECBC, the IMMC-Rock Island, and command's operations and support cost reduction manager developed several options to reduce costs.

Four proposed modifications were eliminating the center heat seal seam, squaring the mitt corners, eliminating a Velcro strap and eliminating the unit pack box. If successful, a total of \$157,000 per year will be saved.

## **C2A1 canister**

The C2A1 canister houses the filter for many of the newer protective masks. The filter assembly screws onto the mask systems. The current configuration uses old metal canning technology and opens up with a key similar to a sardine can. The manufacturing process is expensive and represents a high percentage of the total cost of the filtration system.

A team consisting of IMMC-Rock Island, an ECBC packaging specialist and the contractor, 3M Canada, proposed several packaging solutions to reduce costs. One example solution replaces the can with a less expensive tri-laminate bag while adding an inexpensive cap and plug to protect the filter's fragile screw threads.

Another option with even greater potential savings calls for employ-



Courtesy photo

**By eliminating the center heat seal seam, a Velcro strap and unit pack box, and squaring the mitt corners, a total of \$157,000 per year could be saved with the M295 decontamination kit.**



Courtesy photo

**Recommended changes related to the Laundry Advanced System water storage may result in saving \$280,000 for 140 systems.**

ing two bags to improve the vapor seal while simultaneously eliminating the need for a cap and plug all together. With the current four-year contract and production requirements of 900,000 canisters, the projected savings range from \$1.1 million to \$1.26 million depending on which option is ultimately chosen.

**Laundry system**

The Laundry Advanced System (LADS) is the Army's new water-based mobile field laundry. The LADS comprises a laundry-processing and water recycling equipment. A team consisting of PM-Soldier Support, the command's value engineering manager and the contractor, Guild Associates, looked at high value system issues such as training, water storage, fuel pod and water pump.

The recommendations ranged from process changes to increase system accountability in the field to contract changes to allow the prime contractor to procure the water storage tank, water pump and fuel pod currently procured by Defense Logistics Agency (DLA). The latter proposal would eliminate surcharges and potentially yield significant savings from volume discounts available to the contractor for bulk purchases. Potential savings from implementing the value engineering changes are estimated at \$280,000 for 140 systems.

**Chemical agent monitor**

The Chemical Agent Monitor (CAM)/Improved Chemical Agent Monitor (ICAM) is a hand-held, soldier-operated post-attack device for monitoring chemical agent contami-

nation on people and equipment. The monitor detects and discriminates between vapors of nerve and mustard agents. The CAM/ICAM team consisted of PM-NBC representatives, an NSC representative and the Army Materiel Command value engineering manager. The team determined that the most critical issue concerning the item was readiness.

The team used results of a recent field survey that identified that the lack of proper field maintenance was compromising system operation. The new ICAMs will be fielded to units with CAMs. The displaced CAMs will be moved to other units but will require significant and expensive repairs since most are not in operational condition. Three options were proposed to minimize costs and most effectively solve these issues, from a total upgrade of the existing CAMs to make them into lower maintenance ICAMs to proposing that no CAMs be cas-

ceded, thereby saving significant projected repair costs.

Maj. Gen. John Doesburg, SBCCOM commander, and Col. Steve Reeves, PM-Nuclear Biological and Chemical Defense, attended the out briefs June 9. Doesburg and Reeves said they were impressed with the results of the workshop.

The command's value engineering manager will communicate with each team at the workshop to ensure that the proposed changes are implemented. Furthermore, site visits will be arranged to conduct follow-up mini value engineering workshops to reach those who did not attend this workshop and revisit projects to ensure that the savings have been realized.

These site visits will also serve as a part of beginning to institutionalize value engineering into the command's processes. For fiscal year 2001, the goal will be to review 10 systems for value engineering savings potential.

A second full-scale value engineering workshop is planned for FY2001 at Natick, similar to the one at Edgewood, providing the opportunity for greater participation from the Soldier Systems Center product managers and NSC.

By instituting a value engineering program at SBCCOM, significant cost savings will be realized.

*Editor's note: Kenneth Rice is the Supplemental Programs Team leader at Natick Soldier Center's Operations and Customer Interface Directorate.*



Courtesy photo

**Replacing Chemical Agent Monitors with Improved Chemical Agent Monitors could result in significant savings from unnecessary repair costs.**