ARMY TECHNOLOGY

U.S. ARMY RDECOM®

MAY/JUNE 2014 | VOLUME 2, ISSUE 3

A publication of science and technology news from the U.S. Army Research, Development and Engineering Command

FOCUS: SOLDIER OF THE FUTURE

+PLUS

INTERVIEW WITH LT. GEN. KEITH C. WALKER

MAY/JUNE 2014 | VOLUME 2, ISSUE 3

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DEPARTMENTS

ACRONYM GUIDE

RDECOM	Research, Development and Engineering Command
AMC	U.S. Army Materiel Command
AMRDEC	Aviation and Missile Research, Development and Engineering Center
ARCIC	Army Capabilities Integration Center
ARDEC	U.S. Army Armament Research, Development and Engineering Center
ARL	Army Research Laboratory
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
CERDEC	Communications-Electronics Research, Development and Engineering Center
DARPA	Defense Advanced Research Projects Agency
ECBC	Edgewood Chemical Biological Center
MPDS	Mobile Power Distribution System
NSRDEC	Natick Soldier Research, Development and Engineering Center
PEO C3T	Program Executive Office for Command, Control and Communications-Tactical
PEO Soldier	Program Executive Office Soldier
TARDEC	Tank Automotive Research, Development and Engineering Center
TRADOC	Training and Doctrine Command

Front Cover credit: 2013 RDECOM Noncommissioned Officer of the Year Staff Sgt. Joshua Menninger portrays the Soldier of the future. (U.S. Army illustration by Joe Stephens with photo by Conrad Johnson)
Back Cover credit: U.S. Army illustration by Henry Marnghitr with photo by Tom Faulkner

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Science-fiction writers envision technologies that scientists and engineers often create in the future. Consider the smartphone. Once firmly in the realm of science fiction, we use our "communicators" to not only talk to someone on the other side of the globe, but also to schedule our calendars, check e-mail, or access the Internet. Forty years ago, this seemed unattainable.

Yet Army researchers within the Army Materiel Command and Research, Development and Engineering Command team achieve innovation by imagining something and then creating an idea or concept that can change the nature of the fight.

In the future, quantum communications will enable entangled atoms to pass information with no apparent connection. This means bandwidth will not be an issue. It also means secure communications. We are working on this with the University of Maryland.

We are also working closely with the U.S. Special Operations Command on the Tactical Assault Light Operator Suit, or TALOS. Sensors will give Soldiers a wealth of information, and the suit will provide better protection, enhanced performance and improved situational awareness.

Army Chief of Staff Gen. Raymond Odierno wants us to focus on the squad and individual Soldier, and we are focused on lightening the load both physically and cognitively.

As Soldiers access more data, it becomes a constant stream of information. Those of us who remember the early Internet went through this as it matured from a novelty to a vital, yet sometimes overwhelming connection to the world. During the early days of the Internet the trick was to find information. Then it became finding good information. The same is happening to Soldiers. We need to provide the right information at the right time in a form Soldiers can use. After all, Soldiers use information to make decisions in a split second and often under dire circumstances.

When I served on a submarine in the U.S. Navy, my boat had the latest sonar and torpedo fire-control system. The system could easily overwhelm the crew with the number of screens and the amount of information it provided, but it enabled each of us to configure the output to best support our decision-making process. I see this in the same way. Military technology must provide the Soldier with information best suited to an individual's decision-making process. As researchers and engineers, the more thought put into designing a streamlined, configurable information flow, the better off our Soldiers will be. We will help our Soldiers to make the best decisions with the best information at the speed of battle, which can be the difference between life and death, victory and defeat.

To achieve this end as we move forward with an even more technology-oriented Soldier, our scientists at the U.S. Army Research Laboratory are developing a helmet that can sense who's wearing it. This helmet will provide information contextually tailored by its wearer.

Smart helmets are just one of the technologies that will help provide warriors with information they need. If it takes too long for our Soldiers to evaluate the information, we may lose the fight. Time is critical to their success.

Dale A. Ormond
Director, RDECOM

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We envision a day when squad leaders will have an app that outlines missions and mission requirements. Imagine a squad leader sharing information with his or her team by laying out the mission and specifying the required equipment. Instead of needing a briefing to be told what to do, Soldiers will customize their kit and meet for the first time, ready to execute the mission.

Future American warriors will depend on technologies that better protect them and prepare them for the fight. RDECOM's technology development strategy ties everything together, from lethality to protection.

This integration is critical to the chief of staff's vision of a future Army that will be technologically competent and feature enhanced combat power with fewer Soldiers. Connectivity and integration are critical attributes to enable our technologies to be greater than the sum of their parts, just as the Internet and cloud applications are helping mobile devices rival the power of desktop computers of a few years ago. We have this firmly in mind for the goals of the Army Brigade Combat Team Modernization program for Army 2025 and continuing toward the Army of 2040.

We are focused on developing technologies that give our Soldiers the advantage of an unfair fight. That's our primary motivation. With AMC, RDECOM has tremendous capabilities. Between what we develop and what we help industry modify to meet our specific requirements, there is no one better positioned to accomplish this mission. We will continue to do the necessary work to enable our leadership's vision for the Army of the future.

ARMY TECHNOLOGY

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Concept Development

CONCEPTS PROVIDE A VISION OF HOW THE ARMY WILL OPERATE AND FIGHT IN THE FUTURE

ARCIC develops Army concepts that provide strategic and operational direction through the Army Concept Framework. ARCIC also supports combatant commanders by evaluating capabilities needed for the future force in a range of operational environments.

In many ways, ARCIC is the think tank for the Army. They look at the future, determine the threats the Army will face and the missions it will receive, and come up with the operational concepts required to organize its structures and the capabilities needed to drive its programs.

ARCIC's mission is to develop, evaluate and integrate concepts, requirements and solutions for the Army—across DOTMLPF, warfighting functions, and formations—to provide Soldiers and units the capabilities they need to support combatant commanders. ARCIC actively supports the Army's transition to a future force—one that is focused on developing adaptive leaders and organizations, modernizing equipment and revolutionizing training.

Army Technology talked with Lt. Gen. Keith C. Walker, ARCIC director, about the Army of the future.

Army Technology: How does ARCIC help shape the future Army?

Walker: ARCIC develops concepts and integrates capabilities across doctrine, organization, training, materiel, leadership and education, personnel, and facilities—known as DOTMLPF—warfighting functions, and formations. Concepts provide a vision of how the Army will operate and fight in the future. Concepts determine the capabilities future Army formations will need to operate in support of the joint force commander. We compare the required capabilities against the current Army, which serves as a baseline for capability needs analysis, to determine and prioritize future capability requirements. This also allows us to identify key areas for research and development that in turn identify the science and technology investments the Army needs to make today in order to deliver the capability solutions for the future.

Army Technology: What provides the basis for developing future concepts for the Army?

Walker: The future operational environment provides the foundation for Concept Development. We look at the challenges and threats we will likely face in the future, and through the Campaign of Learning—a series of seminars, wargames, experiments, and studies—we assess how the Army can best meet those challenges.

We also adhere to defense planning guidance with 11 military mission areas. The Army is heavily involved in 10 of 11. Everything from defeat and deter, to defend the homeland, to conduct humanitarian and disaster relief. Since we no longer have nuclear weapons in our formations, nuclear deterrence is not an Army mission area. This guidance describes a very wide range of operations that Army formations must conduct. The breadth of missions reflects exactly what the Army does for the nation. Secretary of War Lindley Miller Garrison, addressing the West Point Class of 1914 stated, "The American Army has become the all-around handy man of the government." He continued: "You may be called upon at anytime to do any kind of service in any part of the world—and if you would not fall below the standard your fellows have set, you must be ready and you must do it, and you must do it well." You must ask if the Army cannot do all the various missions and tasks the nation needs us to do, what good are we?

Additionally, our adversaries will continue to leverage the proliferation of technology and the exponential increase in information exchange to challenge the United States in an asymmetric manner. Specifically, future adversaries will attempt to negate our Nation's technological advantage and long-range precision strike capabilities. That said, conflict has and always will be a human endeavor. The human aspects of conflict will remain the focus of the Army.

We do not have a crystal ball and our best projections of the future will not be 100-percent accurate. However, the art and science of concept development attempts to be not too far wrong. Our goal is to develop concepts that lead to a flexible and adaptive Army that is capable of addressing emerging threats across the range of military operations even when those operations were not predicted.

Army Technology: What is your vision of the future operational environment and how will adversaries challenge us at the tactical and operational level?

Walker: The operational environment is indeed complex, if not chaotic, characterized by a multitude of actors and a wide range of possible threats. Many of our adversaries have adopted anti-access/area denial strategies. The adversary's regular forces, irregulars, our own coalition partners, criminals, refugees, NGOs and others will all intermingle in this environment and interact in many ways.

Each of these actors has an agenda and they often will not be in consonance with our objectives nor with one another's goals. Besides the broad range of conventional weapons readily available on the global arms market, adversaries can select from an array of affordable, but sophisticated technologies and adapt them to create unexpected but lethal weapons.

Why is this important to the Army? Because war is fundamentally a human enterprise, a clash of wills, that involves the immutable human aspect within the nature of conflict. We win wars on land—that is the key factor as employing land power is about the continuation of politics by other means; compelling an adversary to change behavior to achieve our Nation's objectives. Moreover, while all services contribute to the joint fight on land, the forces that operate on land integrate and direct those capabilities at the point of decision.

Army Technology: With so much uncertainty, both operationally and fiscally, how do you address the far term beyond 2025?

Walker: Today, our Army is roughly 1/3 direct combat to 2/3 operational support and sustainment. Some folks call that the tooth-to-tail ratio. In the future, we can expect continued budget pressures, and this means continued pressure to reduce size of the Army, since that is where most of money is spent. Therefore, we need to have more tooth in our tooth/tail ratio even as the total size of the force decreases. At the same time, we must enable expeditionary maneuver by an operationally significant force. The increasing momentum in human interactions drives the need to conduct operations around the globe at the speed of change. Force 2025 and Beyond modernization calls for focusing basic research in a few key areas that could result in a breakthrough that will help us adjust our tooth/tail ratio. Human sciences, material sciences, advanced decision-making, and advanced lethality are examples of areas in which we need to focus our basic research. That also means investing less in other areas as this modernization will happen in a declining fiscal resources environment.

While we may not be able to afford many new programs today, we can adjust our investments in science and technology in order to ensure our Soldiers and formations have the foundations for capabilities they need in the future.

Army Technology: What role will technology play for future Soldiers?

Walker: Technology will play a key role in fundamentally changing the Army to realize the CSA vision. In the area of human science, there are exciting opportunities to enhance human performance, both cognitive and physically. Admiral McRaven, the SOCOM commander, spoke of developing an "Iron Man" suit for special operations forces. What was comic book fiction yesterday is a possibility in the next 10-15 years. Advanced computing combined with next generation of wireless communication offers mobile command centers on the move with unprecedented access to information at the lowest tactical level that includes connectivity across the entire joint force. The individual Soldier in 20 years could coordinate and deliver a lethal attack that exponentially exceeds today's force capability, as well as deliver humanitarian aid and assistance to the exact location where most critically needed. The area of material science offers the potential to deliver the same lethality, protection and mobility of an Abrams tank, but only half the weight.

Robotics can reduce risk to Soldiers by performing some of the more dangerous and physically demanding tasks such as clearing routes and lifting heavy objects. Technological advances are available today to allow for driverless trucks. Lessons we have learned in through manned and unmanned aviation applications can be further expanded in our aviation units and be applied to our ground combat vehicles as well. A lighter, unmanned tank, fighting as part of a combined arms team is a great possibility in the near future.

These areas, along with other research efforts, will change the way the Army fights, trains, sustains and deploys as the leaner, more expeditionary, more capable and resilient force as described in the CSA vision for the future. However, we must not forget the most important point that sometimes gets lost in our exuberance and fascination with technology… technology enables the Soldier, not the other way around.

Army Technology: Are you optimistic about the future?

Walker: Yes. we have been here before. War is often followed by a period of innovation where lessons from the previous war and new technology were combined to develop the Army of the future. We have a great opportunity to set a course for Force 2025 and Beyond.

We understand the future strategic and operational environments that Army formations will likely face when the nation commits those units again. We understand the guidance from our national strategic leaders. We know what the Army must do, and we have a good idea about how Army units must operate differently in the future. As we look to modernize the force for future challenges, we are again doing so at a time of immense budget reductions that forces our leadership to make trades between readiness, force structure and modernization.

This is a tough balancing act. For the last 12 years, we have been in a period of organizational adaptation, driven by the exigencies of two wars, and abundant resources. Our Army adapted well and quickly across DOTMLPF.

Now we enter a period of innovation characterized by limited resources and no definitive, specific threat. One of my favorite sayings attributed to Sir Winston Churchill, "Gentlemen, we are out of money—now it's time to think!" Thinking is hard, but the good news is that thinking does not cost a lot of money.

We need to think first, and then invest. The intellectual must precede the physical as we deliver Force 2025. Finding the best solutions (addressing cost and benefit) to maintain operational overmatch and providing equal or greater capability to the joint force with a leaner Army will not be easy. Beyond 2025, fundamental change in the nature of the force must occur to achieve strategic and expeditionary maneuver against highly adaptive adversaries. To achieve that fundamental change we will need to leverage science and technology to deliver the future capabilities our concepts demand. ■

For the complete interview, visit http://go.usa.gov/kc8H

LIGHTEN THE LOAD

Military research aims to lighten the load through innovation

BY DAVID MCNALLY, RDECOM PUBLIC AFFAIRS

U.S. Army Staff Sgt. John Cooley provides security during a meeting with at Directorate of Agriculture, Irrigation and Livestock in Farah City, Afghanistan, Sept. 28, 2013. Cooley is assigned to Provincial Reconstruction Team Farah. (U.S. Navy photo by Lt. Chad A. Dulac)

Dismounted Soldiers carrying full battle gear are pushed to their physical limits. Army missions demand speed, stealth and stamina with a Soldier often hefting 100 pounds or more of essentials. How will a Soldier of the future maintain the decisive edge in spite of this challenge? The answer may be in innovations developed by the Defense Advanced Research Projects Agency, or DARPA.

"That load is a critical issue," said Army Lt. Col. Joe Hitt, Warrior Web program manager. "In Warrior Web, we want to explore approaches which make that kind of load feel, in terms of the effort to carry it, as if its weight has been cut in half. That's the goal."

DARPA launched the Warrior Web program in September 2011, seeking to create a soft, lightweight undersuit to help reduce injuries and fatigue while improving mission performance.

"The number one reason for discharge from the military in recent years is musculoskeletal injury," Hitt said. "Warrior Web is specifically being designed to address the key injuries at the ankle, knee, hip, lower back and shoulders."

Warrior Web would protect injury-prone areas by stabilizing and reducing stresses on joints and promoting efficient and safe movement over a wide range of activities, he said.

While protecting against injury, Warrior Web also seeks to make Soldiers into better performers by giving them the feeling of a lighter load and enhancing their existing physical capabilities.

"We're assessing new technologies that could even allow a Soldier to run a four-minute mile," Hitt said. "For example, we have components such as motors and springs integrated into a suit which will augment the work performed by the muscles in the legs. This may be a pathway to enhancing performance."

Such performance enhancement may sound like science fiction.

"The theory behind it is if you can provide enough force to the runner, you could probably have them do a four-minute mile," said Michael LaFiandra, chief of the Dismounted Warrior Branch at the U.S. Army Research Laboratory. "We're skeptical because we're researchers and it's part of our job to question everything. But, they're bringing the technology here. They want to demonstrate this four-minute mile concept and we're hopeful that they can do it."

Wearable technologies are the newest buzz in the commercial tech world. Sensors can measure heartbeats, blood pressure and steps taken. This information is useful to an individual interested in trying to live a healthy, active lifestyle. However, the information may be critical to a small unit leader when Soldiers are networked together. A leader would be able to monitor health signs in real time to better evaluate situations and make good decisions.

DARPA, along with scientists from the ARL Human Research and Engineering Directorate tested nine prototype Warrior Web systems on Soldiers over 21 weeks during the first phase of the program.

"I think it has enormous potential," LaFiandra said. "When you look at the amount of load Soldiers are being asked to carry and the various types of terrain they're being asked to carry it over … they need some sort of assistance."

The Army has looked at offloading gear to a robotic asset or even precision airdrops as ways of reducing Soldier load.

"Those methods will be effective to some extent," LaFiandra sad. "The reality still remains that Soldiers are going to be carrying a lot of weight. If we want them to be able to perform their mission and carry this weight, we need to do something to help them."

The initial prototypes went through rigorous evaluation at the Soldier Performance and Equipment Advanced Research Facility at Aberdeen Proving Ground, Md. This facility features a state-of-the art bio-mechanics laboratory where researchers capture high-resolution, highly-controlled data. Immediately adjacent to lab, there is a two and a half mile cross-country course through the woods.

"We can have Soldiers wearing the system walking on the treadmill, measuring how hard the foot hits the ground and how hard their muscles are working, and then have them immediately go outside and climb over stumps and downed trees and walk through water to their ankles if we want them to," LaFiandra said. "We're also developing ways of capturing more of the high-resolution laboratory data in that field environment."

"I think this approach has contributed to our success because all of the performers knew that they would be undergoing independent testing by a very qualified team with an excellent facility," Hitt said.

DARPA is also partnering with the Natick Soldier Research, Development and Engineering Center and Natick Soldier Systems Center in Massachusetts.

"They are one of our stakeholders," Hitt said. "They're part of our Warrior Web community, which will have about 30 different industry, academic organizations and government partners by this summer. They also actively participate by making sure that the technologies created by our performers integrate into existing Soldier systems."

Hitt said ARL-HRED helps them to assess biomechanics and physiology while NSRDEC looks at the Warrior Web technology and makes sure it integrates with Soldier equipment such as body armor, communications gear and weapons systems.

During the first period of testing, known as Task A, researchers are exploring technologies to augment muscle work and increase Soldier capabilities. The team is addressing five key areas:

- Core injury mitigation
- Comprehensive analytical representations
- Regenerative kinetics
- Adaptive sensing and control
- Suit human-to-wearer interface

Last year, DARPA called on industry and academia for proposals to begin the second period of testing, or Task B.

"We received an incredible response and were very fortunate to have a huge pool of very competitive proposals," Hitt said. "Come this summer, we'll announce who we've selected for Task B. I think everybody will be very excited about the teams we've selected."

In the coming months, the team will explore additional wearable technologies not addressed in Task A. The goal will be to integrate "multiple mature component technologies into a system potentially wearable by 90 percent of the U.S. Army population, both male and female."

In September, ARL-HRED researchers will begin intensive testing of the next generation of prototypes.

"Every system will see six Soldiers over a course of three weeks," Hitt said. "ARL-HRED is responsible for that effort. If everything goes as it went last year, it's going to be an exciting event."

DARPA officials said while they are sharing research and findings with the U.S. Special Operations Command, Warrior Web is not part of the Tactical Assault Light Operator Suit, or TALOS, currently under development.

Warrior Web will soon get its final test.

"Thirty months from today, we will outfit a squad with our suits and we will compete against a squad without them in activities such as the 12-mile rucksack march, marksmanship and the obstacle course," Hitt said. "Our vision is to significantly reduce the time it takes to do a rucksack march and then when you get onto the marksmanship course, you're almost as fresh as if you hadn't marched at all." ■

Outreach and collaboration deliver the Tactical Assault Light Operator Suit

BY DONNA MILES, AMERICAN FORCES PRESS SERVICE

U.S. Special Operations Command is using unprecedented outreach and collaboration to develop what its commander hopes will be revolutionary capabilities: a suit that's been likened to the one worn by the "Iron Man" movies superhero that offers operators better protection, enhanced performance and improved situational awareness.

The Tactical Assault Light Operator Suit, or TALOS, is the vision of Navy Adm. William H. McRaven, SOCOM's commander. He challenged industry and defense representatives at a SOCOM conference in May 2013 to come up with the concepts and technologies to make the suit a reality.

McRaven spoke more recently at a February 2014 National Defense Industry Association Special Operations/Low Intensity Conflict symposium in Washington.

"The TALOS program is a collaboration of efforts," McRaven said. "We are teaming with 56 corporations, 16 government agencies, 13 universities, and 10 national laboratories and we are leveraging the expertise of leading minds throughout the country to redefine the state of the art in survivability and operator capability.

"This innovative approach brings together the brightest minds in a national effort and we are already seeing astounding results in this collaboration. If we do TALOS right it will be a huge comparative advantage over our enemies and give our warriors the protection they need in a very demanding environment.

Exactly what capabilities the TALOs will deliver is not yet clear, explained Michael Fieldson, SOCOM's TALOS project manager. The goal is to provide operators lighter, more efficient full-body ballistics protection and super-human strength. Antennas and computers embedded into the suit will increase the wearer's situational awareness by providing user-friendly and real-time battlefield information.

Integrated heaters and coolers will regulate the temperature inside the suit. Embedded sensors will monitor the operator's core body temperature, skin temperature, heart rate, body position and hydration levels. In the event that the operator is wounded, the suit could feasibly start administering the first life-saving oxygen or hemorrhage controls.

Fieldson admitted that the analogy to the suit that the Tony Stark character wore in the "Iron Man" movies may be a bit of a stretch. The TALOS, for example, isn't expected to fly.

But beyond that, there's little that Fieldson—or anyone else at SOCOM—is ready to rule out.

In a departure from past practices of introducing new products piecemeal, adding bulk and weight to operators' kit, the TALOS will be a fully integrated "system of systems," Fieldson said. To offset the weight of computers, sensors and armor that make up the suit, operators will have an exoskeleton—a mechanism that carries the brunt of the load.

"The intent is to have this fully integrated system so you can provide the most capability at the lowest impact to the soldier," Fieldson said. "We think there is some efficiency to be gained if all the equipment is fully integrated as opposed to different components that are simply assembled on the human."

Keeping the systems and the exoskeleton powered will require more than today's batteries can deliver. So along with the TALOS technologies, SOCOM is calling on the scientific and technical community to come up with reliable and portable power sources.

"We are really looking at stretching the bounds of science and technology," Fieldson said.

That's led SOCOM to reach out to partners within DOD as well as industry and academia for help in pushing today's technological limits.

The command is working with the Defense Advanced Research Projects Agency, as well as RDECOM centers like NSRDEC and ARL, among other DoD organizations, to tap into projects already underway.

DARPA, for example, is making headway on its Warrior Web project, designed to boost troops' stamina and carrying capacity without sacrificing speed or agility. The concept includes a lightweight undersuit that would augment the efforts of the wearer's own muscles.

"Many of the individual technologies currently under development show real promise to reduce injury and fatigue and improve endurance," said Army Lt. Col. Joseph Hitt, DARPA's Warrior Web program manager. "Now we're aiming to combine them—and hopefully some new ones, too—into a single system that nearly every soldier could wear and would provide decisive benefits under real-world conditions."

The Natick lab is busy identifying high-technology armor and mobility technologies with plans to integrate them into a first-generation TALOS system ready for demonstration by the end of June, reported Greg Kanagaki, project engineer for Natick's Unmanned Equipment and Human Augmentation Systems Team.

Natick personnel also are serving as subject-matter experts for the TALOS project, particularly in the areas of mobility, human performance and thermal management, Kanagaki said.

Meanwhile, RDECOM officials say their programs have a direct application to TALOS as well.

"[The] requirement is a comprehensive family of systems in a combat armor suit where we bring together an exoskeleton with innovative armor, displays for power monitoring, health monitoring, and integrating a weapon into that—a whole bunch of stuff that RDECOM is playing heavily in," said Army Lt. Col. Karl Borjes, the command's science advisor.

"RDECOM cuts across every aspect making up this combat armor suit," he said. "It's advanced armor. It's communications, antennas. It's cognitive performance. It's sensors, miniature-type circuits. That's all going to fit in here, too."

SOCOM has called on the private sector, too, inviting not just its traditional industry partners, but also those who have never before worked with the command, to participate in the TALOS program.

"There is no one industry that can build it," SOCOM's Senior Enlisted Advisor Army Command Sgt. Maj. Chris Faris said during a panel discussion at the command's MacDill Air Force Base, Fla., headquarters, as reported by the Defense Media Network.

The outreach has generated a lot of interest. SOCOM's TALOS planning session this past summer attracted representatives of 80 colleges, 10 universities and four national laboratories. At a demonstration in July, 80 companies demonstrated technologies ranging from advanced body armor, some using liquids that turn solid on impact, to power supplies to exoskeleton mechanisms.

SOCOM's goal, Fieldson said, is to have a TALOS prototype within the next year and to have the suit ready for full field testing within five years. That timetable is revolutionary for the military research, development and acquisition world, even for rapid-equipping programs.

As the only combatant command with acquisition authority, SOCOM is able to accelerate the TALOS project, Fieldson explained. The command's acquisition executive and research and development staff share a building at MacDill AFB, which he said promotes close collaboration and speedy decision-making.

"We have access that is nontraditional and that absolutely helps us," Fieldson said. "We can bounce ideas back and forth against the leadership and ensure that what we are doing makes sense … I think that is critical to trying to develop this system within the timeline we are working toward."

Also, in a departure from traditional development projects, SOCOM's Acquisition Center staff established an innovation cell to lead the effort, advised by operators and focused on transforming business processes to solve the extreme integration challenges associated with TALOS.

"Because of the technical challenges and the compressed timeline, we are going to take more ownership on the government side than we typically take," Fieldson said.

"We are going to go in and make some decisions that we sometimes rely on industry partners to make for us," he said. "That allows us to reach out to a broader audience. That way, if there is a great idea in some nontraditional organization, we can integrate it" without relying on a commercial company to do so.

"We are really changing the process," Fieldson said. "And the reason we are doing that is to try to streamline the overall effort and drive down both the cost and the schedule. That way, we get the best possible equipment to our force as quickly as possible."

Although the TALOS is initially intended for special operators involved in high-risk missions, it has implications for the conventional force as well, Fieldson said.

"We have a long history at SOCOM of developing things first and then the technology moving out to the broader force," he said. "We fully expect that to happen with this one as well. I think there will be a lot of spinoff technologies that the broader force will be able to use."

Meanwhile, McRaven remains the suit's No. 1 proponent.

"I'm very committed to this," he told industry representatives at a July planning forum. "I'd like that last operator that we lost to be the last operator we lose in this fight or the fight of the future. And I think we can get there." ■

Editor's note: Navy Capt. Kevin Aandahl, U.S. Special Operations Command, contributed to this article.

MANEUVER MOBILITY

TARDEC engineers are exploring future mobility and protection concepts

BY DAN DESMOND, TARDEC PUBLIC AFFAIRS

Above: The first three optionally-manned vehicles negotiate oncoming traffic, follow rules of the road, recognize and avoid pedestrians and obstacles, and then use intelligence and decision-making abilities to reroute direction through a maze of test areas to complete both complex urban and rural line haul missions using the Autonomous Mobility Appliqueì System. (U.S. Army photo by Bruce Huffman)

Left: TARDEC explores future mobility concepts, aiming for radical improvements to allow vehicles to drive over almost any terrain in any environment. (U.S. Army illustration by James Scott)

When Gen. Dennis Via, U.S. Army Materiel Command commanding general, visited the Tank Automotive Research, Development and Engineering Center earlier this year, he said, "We don't know where the next contingency will be, but there will be another contingency."

Via emphasized that regardless of where, "they're going to expect units to be ready to go with the equipment and materiel needed to accomplish the mission and come home safely."

With that in mind, TARDEC engineers are surging forward with projects to support the Army of the future.

"By improving the current vehicle fleet and developing new capabilities, our engineers and scientists are making progress in shaping the Army of 2025 and changing the way Soldiers in the next generation will fight," TARDEC Technical Director Dr. Paul Rogers said.

FUTURE MOBILITY

Envisioning how future mobility will look and function started with the Mobility Demonstrator. Some of those ideas have spun into other key projects, such as the Combat Vehicle Prototype, known as CVP, and the Ground Experimental Vehicle, known as GXV. The GXV is a joint project with the Defense Advanced Research Projects Agency, or DARPA.

Engineers explored future mobility concepts that offer modularity, advanced drive trains and component commonality. They looked at systems such as common chassis, wheels-to-tracks transformation systems, high-power-dense engines, advanced suspension systems, electrified propulsion systems, advanced energy storage systems and advanced thermal management systems. These exercises evolved into future research initiatives, including the GXV.

The GXV has initiated several seedling evaluations involving other Army agencies and academic partners exploring the technical feasibility of advanced—and in some cases, radical—mobility concepts and performance assessments for a smaller, lighter, more agile vehicle that could move over previously inaccessible terrain.

"Operational forces have been limited to the terrain they encounter, and we're researching how GXP could travel over different kinds of terrain," said Paul Decker, deputy program manager for DARPA GXP and Advanced Vehicle Make. "A vehicle with rapid deployability, radically enhanced mobility, lethality and enhanced survivability is within the realm of the possible."

DRIVERLESS MOBILITY

TARDEC demonstrated autonomous vehicle technology at Fort Hood, Texas, earlier this year. Engineers equipped two unmanned Palletized Load System cargo haulers and an M915 tractor trailer to interact with a manned HMMWV gun truck escort, negotiating oncoming traffic, following rules of the road, recognizing and avoiding pedestrians and obstacles, and then using intelligence and decision-making abilities to re-route their direction through a maze of test areas to complete both complex urban and rural line-haul missions.

The system may provide flexibility and adaptability to augment Soldier capabilities and protection. Engineers designed the system to provide a wide range of military vehicle platforms with optionally manned capabilities to increase safety and provide Soldiers with additional flexibility.

Equipped with GPS, LiDAR (Light Detecting and Ranging systems) and RADAR, along with a host of sensors and other high-tech hardware and software components, the system's intelligence and autonomous decision-making abilities can be installed in practically any military vehicle, transforming an ordinary vehicle into an optionally manned version.

Another demonstration with more vehicles and more complex notional scenarios is scheduled for later this year.

"We are very happy with the results, but the AMAS must undergo more testing before it becomes deployable," said Bernard Theisen, TARDEC's lead AMAS engineer. "The vehicles and systems are replaceable, but nothing can replace the life of a Soldier. These systems keep Soldiers safe and make them more efficient."

MODULAR VEHICLE DEMONSTRATOR

TARDEC leadership periodically selects a series of innovation projects featuring new technology development with potential to change how ground vehicle platforms are designed. The Modular Vehicle Demonstrator proposes to assemble interchangeable vehicle pods on a common chassis in the 30 to 55 ton weight class, transforming the way the Army produces vehicle fleets.

The concept would allow a common platform and powertrain system as a base, combined with a series of removable pods to assemble mission-specific configurations. The concept would preclude the requirement for vehicle variants built to perform specific missions, such as carrying a squad, hauling supplies, assault or reconnaissance. The demonstrator program even allows for a driverless application.

"It's all conceptual," TARDEC engineer David Skalny said. "The propulsion unit doesn't change. We're looking at a standard unit length for the chassis and you could put together whichever pods you need to achieve the goal. There's a four-man pod configuration, a six-man configuration, and there are pods for carrying ammunition, supplies, a crane or weapons."

This artist rendering depicts a future combat vehicle assembly line at Detroit Arsenal. High-mobility ground combat vehicles capable of tackling any terrain or environmental condition (track or wheeled) are being "concepted" by TARDEC systems engineers. (U.S. Army illustration by James Scott)

Gen. Dennis Via, Army Materiel Command commanding general, and Heidi Shyu, assistant secretary of the Army for Acquisition, Logistics and Technology, take their seats in the OCP demonstrator buck during a recent TARDEC visit. As a safety measure, OCP design provides dedicated storage areas for weapons and gear so they won't be flung around during a blast event. (U.S. Army photo by Amanda Dunford)

The team has transitioned to full-size vehicle testing to demonstrate the chassis, drivetrain performance and armor solutions using an existing Mine-Resistant Ambush-Protected hull as a test bed.

"The intent of the program is to design a vehicle with extensive modularity, commonality, adaptability and flexibility to perform a variety of missions," TARDEC engineer Mazin Barbat said. "The ability to quickly reconfigure the vehicle for mission-specific needs would give us a significant advantage in speed and flexibility."

The Army has made meaningful investments in laboratories and facilities to validate these technologies. For example, the Ground Systems Power and Energy Laboratory, which opened in April 2012, provides eight laboratories under one roof to test automotive systems under climate-controlled conditions.

In addition, the Vehicle Characterization Laboratory combines a series of vehicle performance and durability simulator devices. And the soon-to-open Vehicle Electronics Architecture Systems Integration Technology Hangar will allow engineers to address power and electronic integration issues, along with in-vehicle hardware and software solutions verification.

At the heart of this strategy is investment in exceptional facilities and talent to achieve the right technology solutions for Soldiers. "If we are successful as a science and technology community, we will fundamentally change the capabilities future Soldiers have to give them overwhelming superiority," Rogers said. ■

Editor's Note: Bruce Huffman, TARDEC Public Affairs Officer, contributed to this article.

NETWORKING the Future Warrior

Creating the Network Modernization Roadmap

BY BRIG. GEN. DANIEL P. HUGHES, DR. PAUL ZABLOCKY AND ROBERT ZANZALARI

Today, the Army has a tactical network that provides commanders and Soldiers with information down to the lowest echelons of the battlefield—but that is held together with the digital equivalent of duct tape and chewing gum.

After a remarkable effort over the past 12 years to rapidly deliver the communications technologies our forces needed in Iraq and Afghanistan, we now have a multitude of sophisticated systems that work well but were not built to work together, requiring significant integration and configuration efforts. Not only did this borne-of-necessity approach lead to increased size, weight and power requirements on our vehicle platforms, it also introduced a great deal of complexity in how Soldiers interact with the network. System startup and shutdown can be difficult. Users are required to memorize and enter multiple passwords and commands. Put it this way: a Soldier expecting the seamless, intuitive user interface of a commercial smartphone or tablet would be sorely disappointed.

As the Army continues to retrograde from Afghanistan and transition to leaner, more agile future Force 2025, we now have the opportunity to change. Our goal is to provide a simplified, integrated network that is robust, versatile and rapidly deployable so we are ready for the next fight. Building on what we learned from previous conflicts, the Program Executive Office for Command, Control, Communications-Tactical, known as PEO C3T, and the Communications-Electronics Research, Development and Engineering Center, known as CERDEC have created a Network Modernization Roadmap that will help guide research and development efforts and smartly direct our limited modernization resources to technologies that will have the greatest short-, mid- and long-term impact on the end user. The roadmap unfolds in three interconnected phases that act as building blocks: Network 2.0 (fiscal 2014 to 2015), Simplified Tactical Army Reliable Network, known as STARNet (fiscal 2016 to 2020) and the Network After Next, known as NaN (2020 and beyond).

Executing this plan will take a total Army effort across the Army acquisition, requirements and test communities, as well as collaboration with partners from industry and academia. Thankfully, the Army Science and Technology community has done its job—looked into the future and given us a head start. With the resident expertise and skill sets, laboratory resources and ability to tap into cutting-edge technology initiatives both within and outside the military, CERDEC is already developing many of the capabilities and standards that lay the foundation for STARNet, NaN and beyond. By aligning these S&T initiatives not just with current programs of record but also with the Army's broader modernization vision, we will drive innovation to support the future force.

CONVERGENCE AND VERSATILITY

We use "Network" as a holistic term—including not just the communications solutions that get information from one place to another, but also everything that rides on that transport pipeline (mission command applications) and enables it to function (cryptographic devices, power sources, command posts). Reflecting this approach, the roadmap is divided into several focus areas: mission command; advantaged services transport, which refers to enhanced capabilities when large communications bandwidth is available; basic services transport, which refers to the assured capabilities of voice, position location, and messaging; cybersecurity and network operations; and physical, which encompasses power and platform requirements and command post footprint.

Our priorities in each of these technology areas are synchronized with the Army's current and future operational imperatives. Take the area of Radio Frequency convergence. As we work to meet the rising demand for data, we know we can't just continue to add more separate radio "boxes," each with their own antennas and other accompanying hardware, and bolt them on to our tactical vehicles. The vision instead is to migrate to an open architecture and vehicle chassis that supports a plug-and-play environment for different functionalities. Cards could be designed and inserted that provide a host for the software necessary for a particular function, while using common transmitters, RF receivers and digital signal processing architecture. The concept applies not only to radios, but also for Electronic Warfare systems, radar and other capabilities that today perform individual functions and create hardware overlap. Creating greater convergence and commonality will enhance versatility, allowing the Army and industry to rapidly develop and insert needed software applications without requiring separate hardware development and installation. It could also result in significant savings over the lifetime of Army platforms by reducing the logistics footprint, simplifying upgrades and providing common training.

The future network will also increase operational versatility by adapting NetOps and Unit Task Reorganization—two areas that multiplied in complexity during the push to digitize. NetOps tools are used by signal soldiers to manage and monitor the network, while UTR is the process by which units adjust their network architectures due to operational changes. As the Army transitions to more expeditionary operations with Regionally Aligned Forces around the globe, Network 2.0 and STARNet aim to make UTR much more automated and flexible. For NetOps, the goal is to converge dozens of current upper and lower tactical Internet tools into a single NetOps tool set that provides total network visibility, overlaid with the common operating picture, for faster response on a complex battlefield.

But convergence doesn't solve the challenges of limited bandwidth and spectrum. While current systems are designed to seek out a specific part of the spectrum, the next-generation waveforms CERDEC is developing for STARNet and NaN will be more dynamic and efficient, so they can identify and re-use available spectrum as required to achieve the needed bandwidth. Another key component for future waveforms is the ability to quickly take a different communications "path" if an existing route is moved or jammed—a difficult task today because of the routing complexity and manual configuration involved. As the Army continues to add network capabilities at the edge of the battlefield, our radios and waveforms must evolve so that they can seamlessly adapt to hostile environments without networking infrastructure—and be as transparent to the Soldier as if he was using his own cell phone.

SIMPLICITY AND SECURITY

That familiar experience is also our goal in the realm of mission command. Picture a Soldier with multiple personal devices that all run an Apple, Android or Windows operating system. While he or she may not have the full capabilities available on a smartphone as on a desktop computer, the applications and environment provide a consistent look and feel. STARNet aims to do the same for the tactical realm by delivering standard maps, messaging and icons that are intuitive to operate and reduce the training burden. By applying the standards and accelerating the objectives of the Army's Common Operating Environment, PEO C3T and CERDEC are driving toward a single tactical computing environment that will provide a seamless user experience from handheld devices to vehicle platforms to command posts.

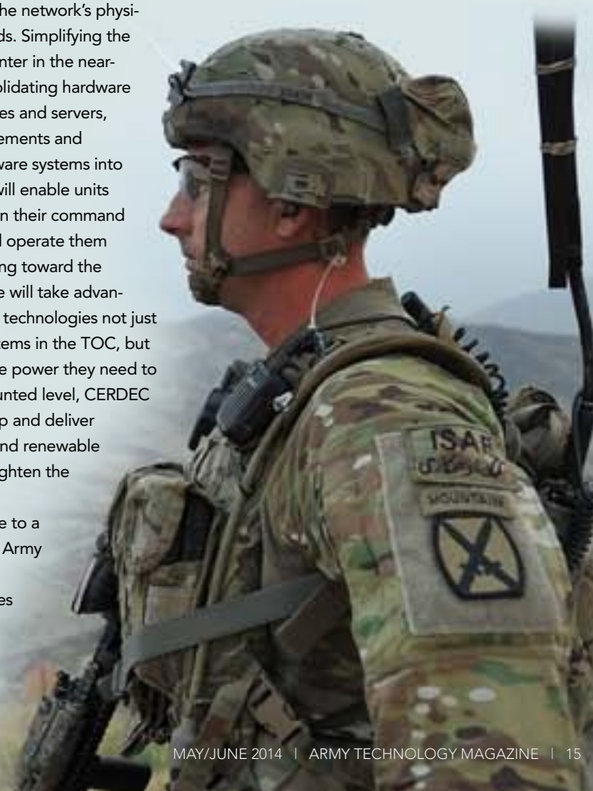
In the long-term NaN timeframe and beyond, the mission command applications delivered through the Tactical CE will be augmented by virtual staff capabilities that can provide the commander or operator with needed information, analyses and recommendations. Working in partnership with the Army Research Laboratory, CERDEC will study the human dimension of such interactions and processes to help determine how technology can ease the staff workload and support faster, better command decisions.

One thing we can be sure of in our next fight is that our adversaries will be more sophisticated in cyber warfare. It is critical that the Army is just as vigilant about protecting the tactical network as it is for the enterprise. CERDEC is partnering with the National Security Agency on a future cyber protection strategy for the tactical network, which not only includes imperatives such as diversified communications solutions, but also steps to protect data at rest and data in transit. The future network will also bring improved tactical capability to execute integrated offensive and defensive cyber operations, so that Soldiers can identify when they are being attacked and respond.

Finally, PEO C3T and CERDEC are making progress on reducing the network's physical and energy demands. Simplifying the Tactical Operations Center in the near- and mid-term by consolidating hardware such as computers, wires and servers, reducing power requirements and converting many hardware systems into software applications will enable units to set up and tear down their command posts more quickly and operate them more effectively. Building toward the Network after Next, we will take advantage of secure wireless technologies not just for networking the systems in the TOC, but also for transmitting the power they need to operate. At the dismounted level, CERDEC will continue to develop and deliver lightweight, portable and renewable energy solutions that lighten the Soldier's load.

The network is core to a smaller, highly capable Army that will face adaptive enemies and adversaries in complex environments. Seizing the opportunity we have today to implement the Network Modernization Roadmap will allow us to fill known capability gaps and make the fundamental improvements to network functionality that will ensure that the American Soldier remains the most discriminately lethal force on the battlefield. It will also lead to cost savings by combining hardware and other infrastructure, increasing competition among vendors, reducing software development efforts and decreasing the number of field service representatives required to train Soldiers, troubleshoot systems and sustain the tactical network. Working together, we can equip our troops with a network that is simpler to use, train, maintain and sustain, so it functions as a holistic weapon system rather than the sum of its parts. ■

Editor's Note: Brig. Gen. Daniel P. Hughes is the Army Program Executive Officer for Command, Control, Communications-Tactical. Dr. Paul Zablocky is the Director of the Space & Terrestrial Communications Directorate, Communications-Electronics Research, Development and Engineering Center. Robert Zanzalari is the associate director of CERDEC.



Eye Armor

Natick takes protective eyewear into the future

BY JANE BENSON, NSRDEC PUBLIC AFFAIRS

When it comes to the very best in vision protection for the Warfighter, researchers at the U.S. Army Natick Soldier Research, Development and Engineering Center make sure the eyes have it.

"Eyesight is fundamental to a Soldier's job, making vision protection of critical importance," NSRDEC researcher Brian Kimball said.

A Warfighter's vision can be impacted by dust, sand, fog and changes in lighting. There are also outright threats from blast and ballistic fragmentation and lasers.

NSRDEC researchers are working to find better ways to prevent sight impairment and eye injury, now and in the future. They are also working on cutting-edge technologies for vision enhancement and shared vision applications.

"At NSRDEC, our mission is the Soldier," Kimball said. "We are honored and humbled by their service, bravery and dedication, which challenge us to pursue science and technology solutions that will enhance their safety, comfort and effectiveness."

"The number of injuries has come down with the use of protective eyewear. Although you can't prevent all injuries, the majority can be avoided, or reduced in severity, by wearing the proper protection," said Michelle Markey, who is involved with the science and technology research at NSRDEC, as well as end-item technical support for both the Army and Marines.

"Improvements are always ongoing," Kimball said.

NSRDEC officials said the success of ongoing vision protection technologies to the collaborative nature of the Department of Defense vision protection community, which has a long history of working together and sharing resources, capabilities and technology.

"This community consists of scientists, engineers, medical professionals and dedicated program and project managers," Kimball said. "These combined resources provide capabilities that could not be realized otherwise."

By wearing eye protection, Soldiers greatly reduce the number and the severity of injuries. (U.S. Army photo)

BALLISTIC FRAGMENTATION PROTECTION

"Ballistic fragmentation protection is always the primary consideration," Kimball said.

Soldiers face a variety of ballistic fragmentation threats, including debris from explosions and weapons firing. They also face increased threats from improvised explosive devices.

Polycarbonate, known for its durability and manufacturability, has long been the Army's staple material for impact resistant eyewear.

However, Army researcheres are taking ballistic fragmentation eye protection into the future. NSRDEC is working to incorporate new, lightweight, transparent nylon materials into protective goggles and spectacles.

"The material is a significant improvement," Markey said. "We are looking at a 15 to 20 percent improvement in impact resistance."

"And it is lighter weight," Kimball added.

This new material, the result of research conducted by Dr. John Song, a materials research engineer at NSRDEC, is approaching the manufacturing stage of product development.

LASER DANGER

Lasers are an increasing threat to Soldiers. Battlefield lasers can cause flash blindness, corneal hemorrhaging, retinal lesions and burns, and possibly permanent blindness.

"Laser light is coherent, collimated and of a single wavelength, so that your eye focuses it to a very fine spot," Kimball said. "In this way laser light is more intense than regular white light."

Handheld versions of lasers are readily available to anyone, anywhere. Military system-based lasers are also becoming more prevalent on the battlefield. Laser hazards can come from systems such as target designators and laser-range finders.

Current laser protective lens technologies use dyes and/or optical films to absorb or reflect laser energy. Natick researchers are aiming to increase the survivability and mobility of warfighters in situations where lasers pose a threat and/or hazard. They are working to provide protection in low light conditions, especially protection that will work better at night. Their goal is to make laser protection part of a single, multifunctional lens system.

NSRDEC researchers, like Brian Kimball, work to advance laser eye protection. (U.S. Army photo by David Kamm)

SAND, FOG AND SCRATCHES POSE CHALLENGES

Researchers continuously face the difficult challenge of developing scratch- and fog-resistant coatings that do not interfere with ballistic fragmentation or laser protection. Natick researchers consider solving this problem is an important priority, because Soldiers tend to take off their eyewear if it is scratched or remove their eyewear when it fogs—thus, sacrificing protection altogether.

"The most common complaints they have in the field are scratching and fogging," Markey said. "We are always looking into new technologies."

Researchers also discovered during desert conflicts that improved scratch resistance coatings are needed to protect lenses against blowing sand abrasion, such as that from sandstorms.

NSRDEC, with support from Program Executive Office Soldier, devised new methods of evaluating abrasion and fog resistance. "We are perfecting and finalizing these new methods of testing and will be investigating new coatings," Kimball said.

A PRESCRIPTION FOR SUCCESS

Many Soldiers wear prescription eyeglasses. Currently, vision is corrected by installing a prescription lens carrier with corrective lenses behind the Soldier's protective eyewear. Technologies currently being investigated by NSRDEC also have application to prescription lenses, and will help make vision correction part of the single-lens system envisioned for the future. NSRDEC foresees this as a joint venture with the U.S. Army Public Health Command and program offices.

One of the most important contributors to successful advancements in eyewear protection is early and frequent testing of new materials and coatings to make sure an advance in one area isn't detrimental to another area. Sometimes new coatings that may protect against scratching or other problems lessen impact protection and have to be abandoned.

"If we have a new capability, one of the first things I do is shoot it (witha ballistic fragment impact simulator)," Markey said.

"The key is to test it as early as you can," Kimball said.

LOOKING INTO THE FUTURE

Hindsight may be 20/20, but future sight will be even better, according to researchers.

The key to future systems, Kimball said, is to "do it all in a single lens format."

NSRDEC researchers are developing an active eyewear system that will protect the user from ballistic fragmentation and lasers, as well as provide vision enhancement in a single lens. The lens will be able to quickly adjust from very clear all the way down to a true sunglass state, allowing the Soldier to more readily adjust to rapidly changing lighting conditions. The system will protect against dangerous forms of light, to include lasers.

In addition to providing protection against numerous threats and adapting to different types of light, a single-lens system would also include vision enhancement.

"The system will have tremendous potential to give the warfighter the edge over opponents and to ultimately lighten their load by providing information and functionality that will one day replace complex stand-alone systems," Kimball said.

Soldiers will benefit from features such as zoom magnification, variable polarization, multispectral enhancement and selective light filtering capabilities. The technology will allow for increased situational awareness and enhanced target recognition. The single-lens system will also feature improved impact protection and hearing protection/augmentation. Energy harvesting technologies are also being investigated to make the system self-powering.

NSRDEC researchers are working to ensure that these new developments will be environmentally robust—meaning it will function under a wide range of conditions without the performance being adversely affected—and low in bulk and weight. Nanotechnology will allow for the creation of new materials, they said.

Eye protection for the warfighter was first developed in the 1940s and included goggles to protect from the sun, wind and dust. From the 1980s until the beginning of the new millennium, new advances in impact protection and laser protection became available. Since then, coatings, materials and capabilities have been improved continuously to ensure the warfighter has the very best protection that technology can offer.

Protective eyewear is crucial to preventing permanent or temporary injuries to the eye in conflicts, past and present. Eyewear protection has proven to be extremely important in recent conflicts in Iraq and Afghanistan, where Warfighters face ongoing threats from improvised explosive devices. Protective eyewear has saved the eyesight of countless Soldiers exposed to shrapnel and the flying debris common with the use of these devices, Kimball said.

"Fortunately for our Soldiers, warfighter vision system research is a challenging area that has attracted some of the brightest minds in the country," Kimball said. ■

MINIATURE ROBOTS

Researchers aggressively explore miniature robots to enhance capabilities

BY TRACIE R. DEAN, ARL PUBLIC AFFAIRS

A small team of elite special forces operators must hunt down a highly sought after terrorist leader. This terrorist has taken refuge in an urban environment which offers concealment behind an array of structures, walls and other obstacles.

In today's Army, this type of scenario may expose Soldiers to a very high level of risk while attempting to locate, identify and engage high priority targets. However, in the future Army, a team of miniature ground and aerial robots may be able to enter the high risk zones and conduct a coordinated search, communicating with one another, and ultimately conveying critical information to Soldiers who are far removed from harm's way.

Micro Autonomous Systems and Technology offers this potential capability and is being aggressively studied by researchers at the U.S. Army Research Laboratory who are collaborating with both industry and academia under a collaborative technology alliance.

"The MAST program seeks to enhance the tactical situational awareness of the dismounted Soldier in urban and complex terrain by enabling the autonomous operation of a collaborative ensemble of multifunctional mobile Microsystems," said Dr. Brett Piekarski, chief of ARL Micro and Nano Materials and Devices Branch within the Sensors and Electron Devices Directorate and cooperative agreement manager of the MAST CTA.

The structure and goals of the MAST CTA were developed by Dr. Tom Doligalski and Dr. Joseph Mait. Mait led the CTA when it was awarded in February 2008. The CTA is comprised of four research centers and numerous consortium members. The research centers include the Platform Integration Center, BAE Systems (lead); Microsystem Mechanics Center, University of Maryland; Processing for Autonomous Operation Center, University of Pennsylvania; and Microelectronics Center, University of Michigan.

Other consortium members include the California Institute of Technology, Georgia Institute of Technology, Harvard University, Jet Propulsion Laboratory, Massachusetts Institute of Technology, North Carolina Agriculture and Technical University, University of California-Berkeley, University of New Mexico and the University of Pennsylvania.

The technical approach to meet the goals and objectives of the MAST CTA is to focus on the critical science and technology research areas as they pertain to small scale platforms including mobility, control and energetics; communication, navigation and coordination; sensing, perception and processing.

In the areas of mobility, control and energetics, researchers are studying aeromechanics at small scales, body and appendage design at small scales, algorithms for complex navigation and small scale platform propulsion and actuation. In the area of communication, navigation and coordination, researchers are focusing on how to enable intelligent communication, networking and collaboration between micro autonomous robotic platforms. Under sensing, perception and processing, researchers are looking at low power sensors for navigation, obstacle detection, and intelligence, surveillance and reconnaissance.

As the originator of the program, Mait commented on the conditions that led to the program's focus and eventual structure.

"In 2005, the world had just witnessed the Defense Advanced Research Projects Agency's grand challenge, which indicated what autonomous systems were capable of doing," Mait said. "The autonomy that was displayed was made possible by large racks of equipment that were put in the back of large SUVs.

"For the types of missions that we had envisioned, the sizes of those vehicles were simply not suitable. We were presented with the problem of taking the level of intelligence that had already been displayed and packaging it into something you can hold in the palm of your hand.

"At the time, we were one of the few in the U.S. looking at this issue. The vision for MAST came about when we realized we couldn't take solutions that worked on large scales and shrink them down for a large platform. It wasn't going to be just a platforms, sensors or algorithms program; we needed to look at the system as a whole which is what led to the genesis of MAST."

Mait, who currently serves as ARL's chief scientist, continued by offering a unique perspective on what MAST means to ARL's program in intelligent systems.

"Since the program was awarded, I am gratified at what has come out of MAST CTA," Mait said. "One being from small company spun out of the University of Pennsylvania that produces little quad-rollers made to fit in the palm of a hand. This device has a large percent of the capabilities that we have wanted. That is a true sign of progress and the types of innovation that we supported through the MAST CTA. Within ARL itself, it has established us now as an organization capable of delivering autonomous platforms that are as large as a passenger vehicle but also as small as something that can be carried around with two arms then also carried in a single hand."

Within the consortium, researchers are confident of their capability to develop autonomous systems at all scales, which Mait believes will open doors and allow for greater creativity.

As for the next generation of MAST and its importance to the Soldier of the future, Piekarski said the program will continue to facilitate the platform that will provide unprecedented operational capabilities to the warfighter.

"We're going to have to have integrated solutions to make those things a reality, and that's where our program is going," Piekarski said. ■

NEXT-GEN PROTECTIVE MASK

Army imagines next-generation protective mask

BY ECBC COMMUNICATIONS

It's hot. Humidity is near 100 percent, and you're in full combat gear—Including chemical-biological protection. Between your helmet and mask, your entire head is covered, leaving a sensation of suffocating heat. Sweat pours as you run, climb and crawl through enemy territory. How can you get through it?

A fan blows soothing air across your face, under the tight-fitted mask.

Technology brings this relief to a Soldier through a powered air purifying respirator, which consists of a hose connected to the face mask from a blower unit and battery pack hanging off the hip or back. A typical respirator is heavy and cumbersome, adding to the weight of the equipment troops already carry.

In 2013, Edgewood Chemical Biological Center scientists began designing concepts for the next generation of chemical, biological, radioactive and nuclear respirators. They developed a fan embedded within the mask's filtration system that uses less power, is lighter and is far less bulky than conventional respirators. In addition to reduced weight and power requirements, this system offers major improvements to the level of comfort and effectiveness of the mask.

The mini-blower works by pulling air through a filtration system on the side of the mask and sweeping it across the nose cup to allow for even flow across the face. When the user exhales, the air valve closes and diverts all of the clean filtered air into the mask's eye cavity to overpressurize the face piece, preventing any potential for outside contaminates to enter the mask should there be a break in the seal.

In test studies, a modified, commercial version of the M50 joint service general purpose mask has proven to be more comfortable to a Soldier, and maintains the same or greater effectiveness when crawling, running, or during rifle exercises and combat maneuvers. These technology demonstrations produced real-time data on mask protection factors, thermal sensation and comfort to the Soldier.

ECBC's Respiratory Protection Branch continues to develop multiple technologies, anticipating integration with next-generation helmet and communication system designs and user needs.

As the team looks ahead, they anticipate a mask that is able to sense when the fan needs to come on and when it should shut off based on physiological monitoring, and the ability of the user to control the scalability (operational mode) of the system: fan off, fan on with airflow just to the eye cavity or fan on with airflow to both the eye cavity and nose cup. ■

Forecasting Future Needs

ARL scientists forecast future warrior needs

BY T'JAE GIBSON, ARL PUBLIC AFFAIRS

Ten to 20 years ago, Army scientists were taking on tough challenges, thinking of the future and wondering how to help American warriors win decisively through technological advantages.

"That's the strength of Army basic research and the essence of our work at the Lab," said Dr. Patrick J. Baker, director of the laboratory's Weapons and Materials Research Directorate, U.S. Army Research Laboratory. "We're taking multidisciplinary approaches to push the frontiers of fundamental science and technology that result in transformational capabilities."

ARL teams with academia and industry, and other government partners to invest in science and engineering as well as manufacturing expertise needed to drive innovation, she said.

The Army is on the brink of transitioning prototype technologies to military users who need them most, like protective robots.

Imagine a squad of Soldiers on patrol, followed by a team of unmanned air and ground vehicles, suddenly coming under fire. But before the enemy can get a clear enough view of the Soldiers in his sights, the air vehicles sense the location of the enemy and informs the unmanned ground vehicle, which rolls open and deploys a protective shield around the Soldiers. That's one kind of protection Army scientists are imagining for future warriors.

Right now, this capability is purely conceptual, according to Dr. Shawn Walsh (pictured above), a researcher leading the Agile Manufacturing Technology team at Aberdeen Proving Ground, Md.

"We're in the early stages of understanding how far we can push current unmanned systems technology," Walsh said. "We have built a lot of support for it and it's pointing to a horizon 10 to 20 years into the future."

As called project CLASP, or Co-Located Assets for Soldier Protection, is a novel use of new unmanned assets in a purely protective role instead of the typical drone usage focused on surveillance and lethality.

"RDECOM [U.S. Army Research, Development and Engineering Command] is well-positioned to not only help set the vision for this concept, but lead novel and unprecedented research to improve and diversify the goal of Soldier protection," Walsh said.

A conceptual protective robotic system: (U.S. Army illustration by Eric Wall)

Walsh said CLASP will protect Soldiers in ways not possible before.

"In essence, there is a confluence of technological advances that are making possible new ways of doing the business of Soldier protection," he said.

Elias Rigas, the Vehicle Applied Research division chief in the ARL Vehicle Technology Directorate, is another researcher involved in CLASP's early work.

"It's important for the Army to pursue cutting-edge, high-risk, high-reward research and also to consider how new technologies developed at the lab can potentially be used to help support Soldiers," Rigas said. "Implementation of technologies in new and out-of-the-box ways can also lead to capabilities that enhance Soldiers' survivability, lethality and effectiveness."

Researchers hope their efforts are an investment in the future.

"A great thing about working in the Army lab is that we have a lot of smart people with open minds working in different areas. If you discover or invent something revolutionary that may be big payoff, it won't be tossed aside just because it is different than how the Army fights today. For a scientist who wants to have an impact, that keeps you pretty excited," Baker said. ■

Interview with James B. Lackey

Since January 2013, James B. Lackey has served as director of Engineering Directorate, U.S. Army Aviation and Missile Research, Development and Engineering Center at Redstone Arsenal, Ala. In January 2014, Lackey became acting technical director of AMRDEC. A native of Maryland, Lackey had a near 25-year career at the Naval Air Systems Command at Patuxent River, Md. He was a strike aircraft flight test project engineer for more than a decade. Between 1999 and 2008 he held a variety of program management assignments. His first senior executive service assignment was at the Pentagon in the Office of the Secretary of Defense supporting the Under Secretary of Acquisition, Technology, and Logistics as the Director of Air Warfare programs. He earned a master of science in engineering management from Florida Tech and a bachelor of science in aerospace engineering from Virginia Tech.

Army Technology: With limited resources, how is the AMRDEC approaching the future? Is there an impact on the Future Vertical Lift program?

Lackey: Wherever and whenever there's an opportunity to combine requirements into a joint service solution, that's a great example of better buying power in action. Going forward, the Department of Defense acquisition community must be more open to these opportunities. It doesn't necessarily have to be at the system level. Through open systems architectures, leveraging commonality of procurement at the component level is still beneficial. Anyplace we can collectively push the state of the art, drive down risk and realize win-wins is a good place to be. We must think positively and proactively on partnering and teaming. Even outside of DoD, we're bridging academia and NASA for project collaboration and research. For example, we're standing up an Additive Manufacturing Integrated Product Team with NASA Marshall Space Flight Center. This is where working-level engineers will collaborate on technology development and how we can leverage what NASA is already accomplishing in terms of facility investments. We clearly recognize the game changing aspects of 3D printing. It's the next Industrial Revolution wave. In such a rapid evolving dynamic area of technology development, partnering with NASA makes great business sense and also helps us to locally foster what is notionally called "Team Redstone," where cross-organizational partnerships are producing incredible results each and every single day.

Regarding FVL as a future program of record, from what I can infer based on both my discussions and what I've heard from the requirements community this effort appears to me to be on a solid footing in regard to budget planning. I say this with the caveat that I do not control the budget; any great plan is subject to change. However, many future operational concepts focus on increased distribution of forces and growing anti-access / area denial threats, known as A2AD. Ensuring dominance over A2AD equates to increased emphasis on mobility, speed and range ideally enhanced with a reduced, logistical footprint. Beyond A2AD, the world will continue to see very dynamic unforeseen threats that must be responded to quickly and with overwhelming force. Future rotorcraft platforms in a wide variety of mission applications against common core designs will help realize the expeditionary Army vision. The requirements of FVL are reflective of this quick response mission role. Today's aging rotorcraft platforms just do not have the performance capabilities to meet these operational demands. Beyond performance, abilities to sustain aging systems will inevitably lead to higher operational and sustainment costs. New capabilities, smartly designed for reduced sustainability costs must be brought into the hands of the Warfighter in the 2030 timeframe. This is what FVL is all about. I would consider it one of the key enablers of the future force.

To get to FVL we must reduce risk and mature technologies. At AMRDEC, we are leading the Joint Multi-Role Technology Demonstration program, known as JMR-TD. This program is designed to show that new aircraft configurations populated with new technologies can help inform a future materiel program-of-record FVL solution. I say the word "inform" deliberately since JMR-TD should not be looked upon as some sort of prototype fly-off effort. The acquisition strategy is clear. JMR-TD is to inform a future program effort. We are approaching this in a very holistic sense. It's not just about an airframe. It's the total rotorcraft system. This includes joint common architecture mission systems, multispectral sensors, energy efficient power and propulsion, as well as sustainment through prognostic and diagnostic novel technologies. We are also conducting cost analysis for future capabilities to help inform trades. AMRDEC's value is our engineering excellence. Working side by side with contractor teams on the JMR-TD, we will help drive down risks, push technology developments and work toward systematically and affordably informing FVL program requirements to ensure future execution success.

Army Technology: Recently Army leaders praised the manned/unmanned teaming of the Shadow/OH-58, and said the Army of 2025 will feature more such teaming. How are AMRDEC engineers and researchers involved with this initiative?

Lackey: AMRDEC engineers are directly matrixed in support of the program offices associated with these platforms and bridging capabilities through enabling manned/unmanned teaming effects. Manned/unmanned teaming is about the power of leveraging sensors and systems to increase intelligence, surveillance and reconnaissance presence and reach. Information is king. With limited assets we must pull for combined effects. In a dynamic and complex battlefield environment susceptible to

countermeasures, robust information distribution is essential to ensure complete engagement of the kill-chain. Beyond Shadow/OH-58, AMRDEC has also done work to produce a manned/unmanned common architecture to demonstrate advanced, embedded mission avionics implementation for the Apache program office. AMRDEC is now working on defining the concepts of operation and human-machine interface for more effective manned/unmanned teaming and optionally piloted vehicle operations. Key to this effort is development of mature, integrated and validated decision aiding technologies hopefully built upon joint common architecture standards to help modularize future software and hardware builds so that obsolescence and technology can be easily and most importantly, affordably inserted.

Army Technology: The Army wants to identify technologies that will allow the force to become leaner but have equal to or greater than capability when compared today. How is AMRDEC approaching this?

Lackey: AMRDEC is partnering very closely with the TRADOC Centers of Excellence and the program office communities to define executable, affordably focused missile science and technology development roadmaps associated with the following potential 2025 transitions:

Ground Tactical to improve direct fire weapons supported by indirect fire, air-delivered fires and nonlethal engagement means. This includes development of a Lethal Miniature Aerial Munition System supported by a Precision Fires Manager to give small unit situational awareness, lethality and survivability against a wide variety of threat targets including operations in dense urban terrains.

Fires operating at greater distances and increased precision. Specific near-term efforts include GMLRS [Guided Multiple Launch Rocket System] tail control modifications to increase range in the same form factor at equivalent hardware costs.

Increased ground troop protections against a variety of incoming, advanced threats. Efforts include development of an Extended Protection and Survivability System to provide counter rocket, artillery and mortar intercept and unmanned aerial system capabilities.

For aviation weapons, AMRDEC is leading the way to develop concepts for modular missile technologies that will ultimately enable common component insertions (i.e., guidance and navigation control units) to support multiple missile configurations via open systems architectures. We expect to do flight tests starting in the 2020 timeframe.

For Aviation, it's all about JMR-TD feeding into the FVL program of record. In the 2025 timeframe, development will be still ongoing, however, we're still overall on track to support a 2030 capability.

These times are notional. Keeping to dates is contingent on multiple factors most importantly including the budget. The main takeway is that AMRDEC works lock-step with our TRADOC points of contact to understand the future requirement and we partner with our program office contacts to ensure an S&T transition plan into a ultimate program of record.

Army Technology: How important are partnerships in industry, academia and across the military to AMRDEC's research and engineering initiatives vis–à–vis building the Army of 2025 and beyond?

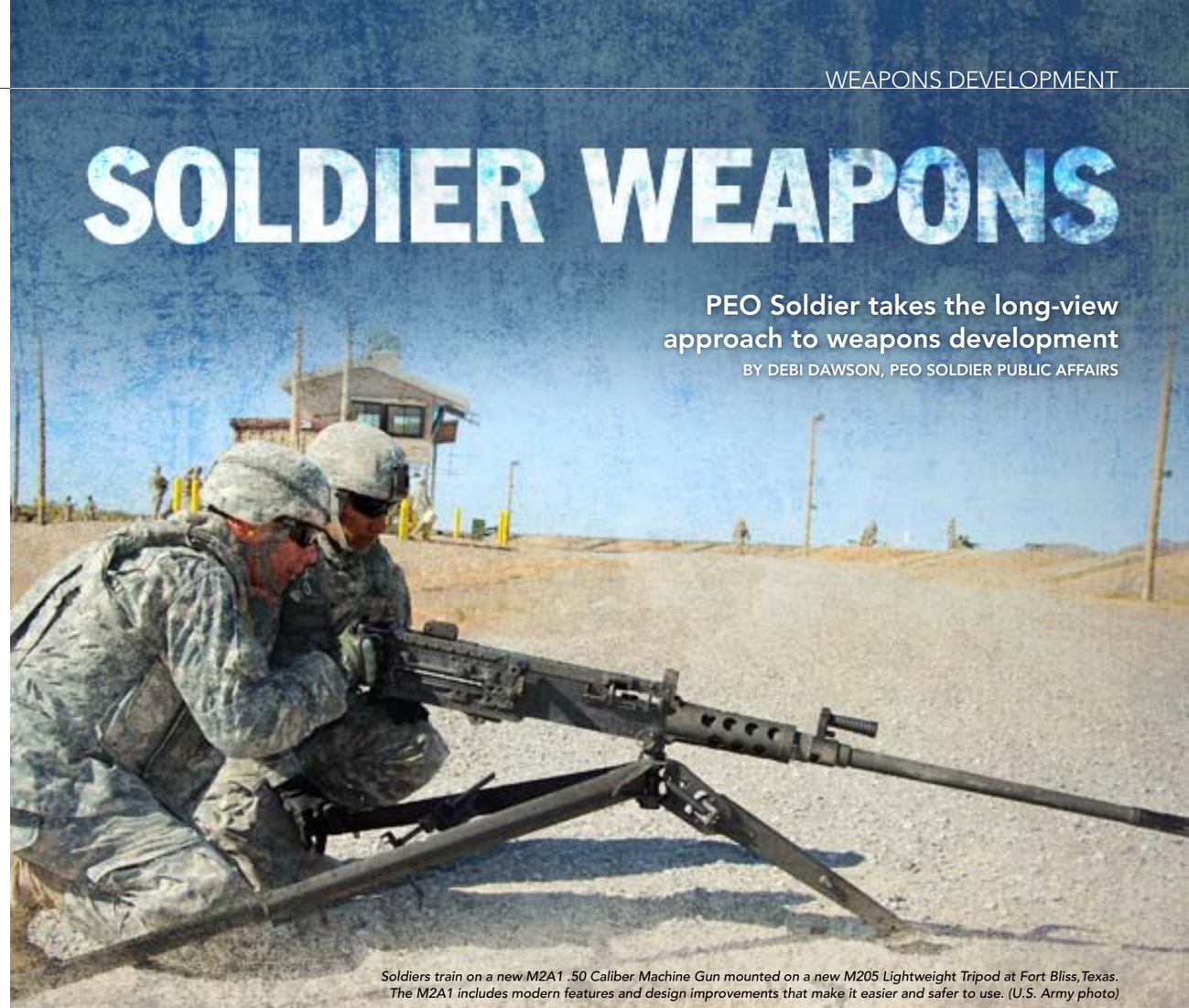
Lackey: I endeavor to write weekly Director's Corner articles to the AMRDEC workforce. One recent topic centered on what I call "Enterprise Collaboration." The key message in the article focused on the essential need to partner across the board: industry, academia and military. It isn't a "nice to have"—it's instead an essential part of our business model. This is driven by two key dynamic factors: the reduced budget and technology change. In a reduced budget environment we must be creative in partnering to leverage effects and outcomes. When you investigate these potential opportunities, it's amazing what you can find in terms of common interests. In regard to technology, rapid change necessitates the need for AMRDEC to keep abreast of latest efforts. With a restricted staff size contingent on a balanced risk approach using both customer funds and overall Army manpower considerations requires us to continually reach out and partner to gain additional insights we could not normally have achieved alone. AMRDEC is all about collaboration. I view this as central to our strategic framework and how we operate as an aligned organization.

We recently celebrated our 50th Anniversary this past month. Given what I've seen and been part of leading this organization, I have no doubt we will continue to prevail in delivering game changing technologies to ever promote dominance in ever increasing complex and evolving battlespaces. As acting director, I am continually humbled and proud to be a team member of our workforce. We have a cadre of acquisition professionals demonstrating excellence and depth and breadth of our activities across the lifecycle from early S&T to fielded systems sustainment. AMRDEC adds value across the board, affordably with adherence to Army core values and with an ever enduring eye to supporting our number one customer—the Soldier.

SOLDIER WEAPONS

PEO Soldier takes the long-view approach to weapons development

BY DEBI DAWSON, PEO SOLDIER PUBLIC AFFAIRS



Soldiers train on a new M2A1 .50 Caliber Machine Gun mounted on a new M205 Lightweight Tripod at Fort Bliss,Texas. The M2A1 includes modern features and design improvements that make it easier and safer to use. (U.S. Army photo)

As the Army's materiel developer for small arms, PEO Soldier's Project Manager Soldier Weapons continues to enhance the capabilities of current weapon systems while it pursues future Soldier needs identified by user communities, such as the Maneuver Center of Excellence.

In 2013, PM SW began taking part in Army's strategic modernization planning process, which incorporates an indepth process to create a clearer picture of what the future looks like out three decades from now. The next generation of small arms that will arise from this process will be an outgrowth of coordinated efforts that align the identification of capability gaps with materiel development and the science and technology investments needed to bring the world of the possible into the realm of reality. The resulting weapon systems will be lighter and more accurate, durable, reliable, and ergonomic. Significant performance improvements will be seen through advanced weapon system enablers, including fire control, which integrates technologies such as ballistic calculators, range finders, target tracking, and environmental sensors.

"Looking to the future, fire control is a critical field for us to advance if we are to maintain our overmatch against a determined adversary," said Col. Scott C. Armstrong, project manager Soldier Weapons. "These systems provide a way of realizing the full potential of our small arms weapon systems by helping Soldiers acquire and engage targets with precision."

The effort to modernize the Army's small arms fire control is the subject of this year's deep dive process. The review is considering fire control for crew served, volume, precision, counter defilade, and squad systems. The deep dive process will help Army leaders make informed decisions that maximize capability. This is particularly important for an Army that is operating in an economic environment where costs and benefits are scrutinized more so than at any point in the past decade. While the return on

investment for fire control is considerable, the cost for a particular system may exceed that of the weapon it enables.

"The path forward for fire control will focus on increasing Soldiers' capability to get first round effects during the day, night and under all climatic conditions," said Lt. Col. Toby Moore, Chief, Lethality Branch, Soldier Division, Maneuver Center of Excellence. "We're looking to reduce a Soldier's overall time of engagement while increasing the range at which Soldiers can detect, recognize, and identify targets."

As the ability to communicate digital information on the battlefield comes online through programs like Nett Warrior, a whole new arena of command and control and target sharing will begin to emerge, ushering in a new generation of potential capabilities. Target tagging, tracking, virtual pointing and target handoff are just a few of the capabilities being explored to enhance the lethality of next generation Soldiers.

Remote weapon stations also are high on the priority list. Since 2007, the Common Remote Weapon Station, known as CROWS, has provided units with tremendous capability for enhanced lethality, situational awareness, and survivability by allowing Soldiers to fire a weapon from inside an armored vehicle or protected location rather than from a space where they are exposed to direct enemy fire. The system's integrated fire control provides Soldiers with fire superiority as a result of its ability to turn area weapons, such as the M2A1, into on-the-move precision-engagement weapons.

"We continuously seek to enhance Soldier lethality by providing the capability to defeat the enemy at ever greater distances," said Armstrong. "In the future, we hope to leverage our expertise with remote weapon systems by assisting the Army in its efforts to integrate small arms onto other remotely operated platforms."

MAINTAINING AND MODERNIZING

The Army has systematically worked to keep its combat-tested small arms fleet in good working order throughout a decade of warfare. However, the Army continues to sustain, improve, and modernize its small arms in a manner that keeps systems in operation longer.

"The term 'old' has an entirely different meaning in the world of small arms," said Mike Friedman, director of Logistics for PM SW. "Small arms weapon systems don't share the same obsolescence cycles as some products like electronics or computers do. Age is not the yardstick, performance is."

Weapons are routinely inspected and gauged in the field. When determined to be worn and unserviceable they are overhauled at Anniston Army Depot, Ala., to ensure proper performance. When the weapons do go through the depot overhaul program, technicians add the latest subsystems, and components to bring the weapon up to the latest specifications, thereby extending its useful life for many years. The result is essentially a service life extension program that takes advantage of S&T advances that become available and are "cut in" on a rolling basis.

The M2A1 includes modern features and design improvements that make it easier and safer to use.The M2 Machine Gun is a good example of a highly effective "old" weapon system design dating back to 1933 that has benefited from the insertion of S&T that will keep the weapon relevant well into the future. The Army is in the process of upgrading its fleet of M2s to the M2A1 configuration primarily through a modification kit applied at depot. The M2A1 includes modern features and design improvements that make it easier and safer to use, including a quick change barrel, fixed headspace and timing, and a new flash hider that reduces the weapon's signature by 95 percent during nighttime use. The upgraded gun also gets an upgraded tripod in the M205, which is 16 pounds lighter than the M3 Tripod it replaces and incorporates a modern traverse and elevation mechanism.

The M4 Carbine is another example of the Army's practice of continuous modernization. M4 systems have benefited from more than 90 performance-enhancing "Engineering Change Proposals" since they were first fielded. Now underway is the M4 Carbine Product Improvement Program initiative to upgrade the Army's M4s to the M4A1 that delivers increased sustained rate of fire, reliability, durability and enhanced ergonomics with the incorporation of an ambidextrous fire control to the design.

"Lighter barrels, shorter barrels, quick change barrels, improved bipods, collapsible buttstocks—there are numerous upgrades underway across the small arms portfolio, that have been cut into depot overhaul," Friedman said. "We continue to enhance while we sustain."

Over time, advanced materials such as carbon fiber, barrel coatings, and other S&T developments will be integrated into the weapons that will not only enhance weapon performance but also reduce lifecycle sustainment costs.

INVESTING IN THE FUTURE

To select and implement S&T investments over the long term, the Army arms itself with knowledge in the near term. For example, the Army is currently pursuing its Small Arms Ammunition Configuration study to identify the optimal caliber for small arms capabilities. The study is an acknowledgement that there is more to combat effectiveness than just the weapon. The MCOE's combat effectiveness "formula" is Combat Effect = Soldier + Weapon + Enablers + Ammunition + Training or SWEAT. The SAAC study will inform future small arms requirements and determine the caliber potential in conjunction with associated weapon and fire control technology. The study is also in synch with the Army's new approach to the material aspects of SWEAT, which is now focused on first achieving enhanced, consistent terminal effects on a particular target set through the right ammunition before considering other aspects of the weapon system that could be upgraded for increased lethality. Numerous other efforts could potentially be influenced by the study to include tactics, techniques and procedures surrounding training and logistics.

Whereas in the past, the prioritization of effort was sometimes based on budgets stretching just a few years into the future, prioritization now considers capability gaps conceptualized across decades. Through the strategic modernization planning approach, the small arms community now has a significant collaboration process in place that looks at emerging requirements 30 years into the future and backs into the science and technology needed to make it happen.

To get to that future, officials at PEO Soldier said they continue to work closely with partners in the requirements and S&T communities in the "constant pursuit of the capabilities that enhance our Soldiers' survivability, lethality and the ability to dominate in any environment." ■

HANDS-FREE NAVIGATION

Researchers develop hands-free, eyes-free navigation for Soldiers

BY JOYCE M. CONANT, ARL PUBLIC AFFAIRS

Researchers at the U.S. Army Research Laboratory continue to develop and evaluate methods for navigation and communication that are 'hands-free, eyes-free and mind-free' to aid Soldiers in the field.

Soldiers wear a lightweight belt around their torso, containing miniature haptic technology. The belt provides vibratory or tactile cues allowing a Soldier to navigate to map coordinates and receive communications while still carrying a weapon.

Research said initial feedback from testing the device is positive. Soldiers say they liked being able "to concentrate on other things and not the screen."

Soldiers are able to move and communicate while keeping visual map displays in their pockets and their eyes on the surroundings.

Vibratory signals are communicated through tactile actuators inside the device. Navigation signals correspond to vibrations or pulses that tell the Soldier which direction to go.

"Data are still being compiled, however, it is clear that Soldiers rarely looked at the visual display when the tactile belt was 'on,' Soldier feedback was very positive," said Gina Hartnett, from HRED's Fort Rucker, Ala., field element. "This assessment gave us a great example of how a device can free up the senses so effectively. Course times were faster on tactile assisted navigation legs. Soldiers reported being more situationally aware of their surrounding because they rarely if ever had to take their eyes off of their environment. Additionally, not having to interact with a visual display, allowed their hands to stay on their weapon."

As long as the tactile sensation is felt at the front of the torso, the Soldier moves forward. If the sensation is at the side or back, the Soldier simply turns until the GPS-enabled signal is felt at the front.

At the same time, communications are also provided by tactile means that can be from other Soldiers or more intelligent ground robots—such as status updates or warnings regarding potential threat.

The vibration, or sensation the Soldier feels, determines what the Soldier is supposed to do or the task they are to perform and is based on the tactile language that is developed—such as with Morse code.

The patterns are developed to be distinct, unique and consistent with the information at hand, to allow the Soldier to quickly and easily interpret the cues. For example, hand signal information or specific messages such as 'robot battery low' can be assigned to patterns, learnt and recognized.

One may think of the vibration signals as similar to different ring types on your cellular phone. A person may know who is calling without actually looking at the screen to see the person's name or number. It is the sound that provides the alert—not the actual sight of it.

Tactile actuators could be placed in any number of objects—such as a glove, belt, inside the helmet or vest.

Researchers from the ARL Human Research and Engineering Directorate's Fort Benning, Ga., field element are testing such tactile systems for navigation and/or communication during mission-relevant exercises to determine the effectiveness of these devices while wearing them and seeing how they perform during actual use. Soldiers quickly learn the system, attaining proficiency with the signals within 10-15 minutes.

Soldiers recently participated in an assessment of the NavCom system at Fort Benning, to evaluate simultaneous presentations of navigation and robot communication/monitoring using tactile patterns of two types of advanced tactors during operationally relevant scenarios. Researchers asked Soldiers to complete several combat-related tasks during this exercise.

The scenarios involved night land navigation on equivalent courses of about 900 meters. While navigating from waypoint to waypoint, Soldiers also received communications from a hypothetical autonomous robot regarding either the robots status or a possible threat detected by the robot. Additionally, Soldiers negotiated exclusion zones and identified enemy targets along the course.

The system automatically collected data, such as time to each waypoint and accuracy to each waypoint. Observer-based data collection included accuracy of robot alerts, number of times Soldiers looked down at their screen, took their hand off of their weapon and correctly identified a target on the course. Subjective data were also collected in the form of a workload assessment and questionnaire followed by an after action review at the end of the night.

Harnett said that some specific comments from the Soldiers included: "I was more aware of my surroundings;" "I don't land nav much, but this made it a no-brainer;" and "I loved the belt, it worked perfectly."

"This stream of research is very dear to my heart," said Dr. Linda Elliott, from HRED's Fort Benning field element. "It's not often a Soldier can pick up a piece of equipment, be trained in five to 10 minutes and have a very positive experience. In a previous night study, Soldiers said they were blind (night, fog, rain, night vision devices fogging up, etc.) and the belt led them straight to point, allowing them to focus attention on their surroundings."

Elliott said the system supports the three basic Soldier tasks—move, shoot and communicate—all while allowing individuals to move more quickly, accurately, find more targets and be more effective at covert communications.

"At the same time, we are trying to collect more basic data, to identify the factors that make a tactile signal 'salient'—easily felt, immediately recognized and distinguished from others. That has to do with the type of tactile signal strength (and other engineering factors), individual differences (such as fatigue), and environmental factors."

Tactile systems for military performance have demonstrated their potential with regard to capability achievement and performance advantage, across a number of applications. Experiments and demonstrations have been conducted across a wide range of settings, from laboratory tasks to high-fidelity simulations and real-world environments.

Several ARL studies have been conducted within the context of Soldier land navigation to investigate effects of tactile cues in context. Many of these studies have been published as ARL technical reports.

Elliott said that subsequent experiments proved the value of tactile systems to support Soldier navigation and communication, but at the same time, systems must be improved and refined before they can be practical in combat situations.

"They must be made lightweight, comfortable, rugged, networked within a command and control system and they must be easy to use and easy to maintain," Elliott said. "As tactile displays are increasingly used for communication of more complex and multiple concepts, it will become evident that tactile and multisensory systems in general must be designed for rapid and easy comprehension." ■

CERDEC enhances C4ISR product lifecycle data management capabilities

CERDEC and TARDEC worked together to customize and implement a commercial software tool, known as Windchill, as part of the Army Materiel Command effort to establish the AMC Enterprise Product Data Management System.

CERDEC engineers collaborated with TARDEC to leverage its use of the Product Lifecycle Data Management system, along with existing modular engineering tools. The team accelerated implementation of its own Windchill-based PLDM scheduled to launch in spring 2014.

The Windchill-based system will provide increased capabilities to optimize product development and sustainment processes and achieve programmatic goals better, said Robert Vella, CERDEC PRD deputy director.

Windchill serves as a technical data repository for managing a product's lifecycle. It allows engineers and technical personnel to manipulate and analyze data through methods such as configuration management and quality tracking during the product's lifecycle.

CERDEC can easily expand Windchill to accommodate additional functions and processes as required, Vella said.

"Broader implementation across the Team C4ISR community of practice will serve to improve Warfighter support," he said.

Read more at: http://go.usa.gov/kcRx

Army software researchers develop MRAP simulator

Army software engineers faced a challenge: Saving Soldiers' lives. With the development of new simulation applications, Soldiers can now use advanced computers to train for worst-case scenarios.

U.S. Special Operations Command representatives visited the U.S. Army Aviation and Missile Research, Development and Engineering Center in the fall of 2012 to meet with Army engineers at Redstone Arsenal, Ala.

The SOCOM visitors saw a Humvee simulator in a Software Engineering Directorate (SED) laboratory where a vehicle traveled down roads simulated by large screens placed in front of the vehicle. Soldiers could ride in the vehicle and walk beside it while a simulated enemy engaged the Soldiers.

The AMRDEC SED is behind the popular America's Army video game.

The experience was both realistic and helpful to the visitors, who asked for the possibility of an MRAP simulator, SED Director Dr. Bill Craig said. MRAPS are the Mine-Resistant Ambush Protected vehicles added to the Army inventory during recent conflicts.

Eighteen months later, the Army software engineers have delivered. The Army now has a new simulator called the Transportable, Reconfigurable, Integrated, Crew Trainer, or TRICT. It is fully operational to train Soldiers and save lives.

"The TRICT is a fully immersive crew trainer for the MRAP," Craig said. "TRICT supports Warfighter capabilities for training individually or collectively as a crew the skills required to operate features of the RG-33 and MATV variant MRAP vehicles."

Read more at: http://go.usa.gov/kGEJ

CRESS kit ready to enter new acquisition phase

A small easy-to-use and lightweight explosive screening kit continues to move forward towards full fielding as a means to provide Soldiers in the field with the capability to screen for suspected homemade explosive materials.

Using proven colorimetric chemistry, the handheld Colorimetric Reconnaissance Explosive Squad Screening, known as a CRESS kit, uses chemical reagents stored inside a specially designed four-compartment plastic container. The reagents produce color changes when they come in contact with four specific HME precursor chemicals. These precursors consist of two fuels and two oxidizers that could indicate the presence of explosives. The kit needs no power source and produces test results in less than two minutes.

The CRESS kit transitioned from the U.S. Army Edgewood Chemical Biological Center to Joint Project Manager Guardian as a program of record Oct. 1, 2013. The military can now facilitate low-cost commercial production.

"The CRESS kit is a perfect example of how ECBC can use its expertise in chemistry and engineering to rapidly develop a solution for the soldier," said Dr. Way Fountain, ECBC senior research scientist for chemistry. "Leveraging the Center's expertise in 3D printing and rapid prototyping allowed us to quickly innovate to a unique design for the handheld kit."

Read more at: http://go.usa.gov/kqxx

Army chemists create human-on-a-chip technology

There was a time when the thought of manufacturing organs in the laboratory was science fiction, but now that science is a reality.

Army scientists at the Edgewood Chemical Biological Center and academia collaborators have been conducting research of "organs" on microchips. ECBC is one of a few laboratories in the world conducting this research effort, but what sets ECBC apart is that its research will directly impact the warfighter.

The center houses the only laboratories in the United States that the Chemical Weapons Convention permits to produce chemical warfare agent for testing purposes. ECBC will test the human-on-a-chip against chemical warfare agent to learn more about how the body will respond to agent exposure and explore various treatment options for exposures.

While the center will be collaborating with the U.S. Army Medical Research Institute of Chemical Defense, Wake Forest, Harvard and the University of Michigan on the design of the chip, the testing will take place at ECBC.

The five-year research project is being funded by the Defense Threat Reduction Agency, and will focus on a platform of in vitro human organ constructs in communication with each other.

Read more at: http://go.usa.gov/kcNQ

STRENGTH OF THE NATION

EDGEWOOD CHEMICAL BIOLOGICAL CENTER

The Department of Defense called on the Edgewood Chemical Biological Center and other organizations at Aberdeen Proving Ground, Md., to develop a way to destroy chemical weapons. In six months, the team produced an operational model of the Field Deployable Hydrolysis System. Through unprecedented collaborative efforts, ECBC led the effort through full lifecycle development, test and evaluation. As a result, the FDHS can neutralize bulk amounts of known chemical warfare agents and their precursors at a 99.9 percent destruction efficiency rate, converting chemical warfare materiel into compounds not usable as weapons.

ECBC and the Defense Threat Reduction Agency signed a technology transfer agreement June 27, 2013, with the Joint Program Executive Office for Chemical and Biological Defense. In January 2014, two FDHS units were installed on the MV Cape Ray as part of the United States' support to the joint mission between the Organisation for the Prohibition of Chemical Weapons and the United Nations to destroy Syria's chemical agent stockpile.

From left to right: **Jeff Gonce** - Chief, Field Maintenance Branch, **Anna Kirby** - Chemical Engineering Technician, **Frank Reinsfelder** - Chemical Engineering Technician, **Ann Brozena** - Research Chemist, **Elan Kazam** - Mechanical Engineer, **Jeff Mott** - Chemical Engineering Technician.

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