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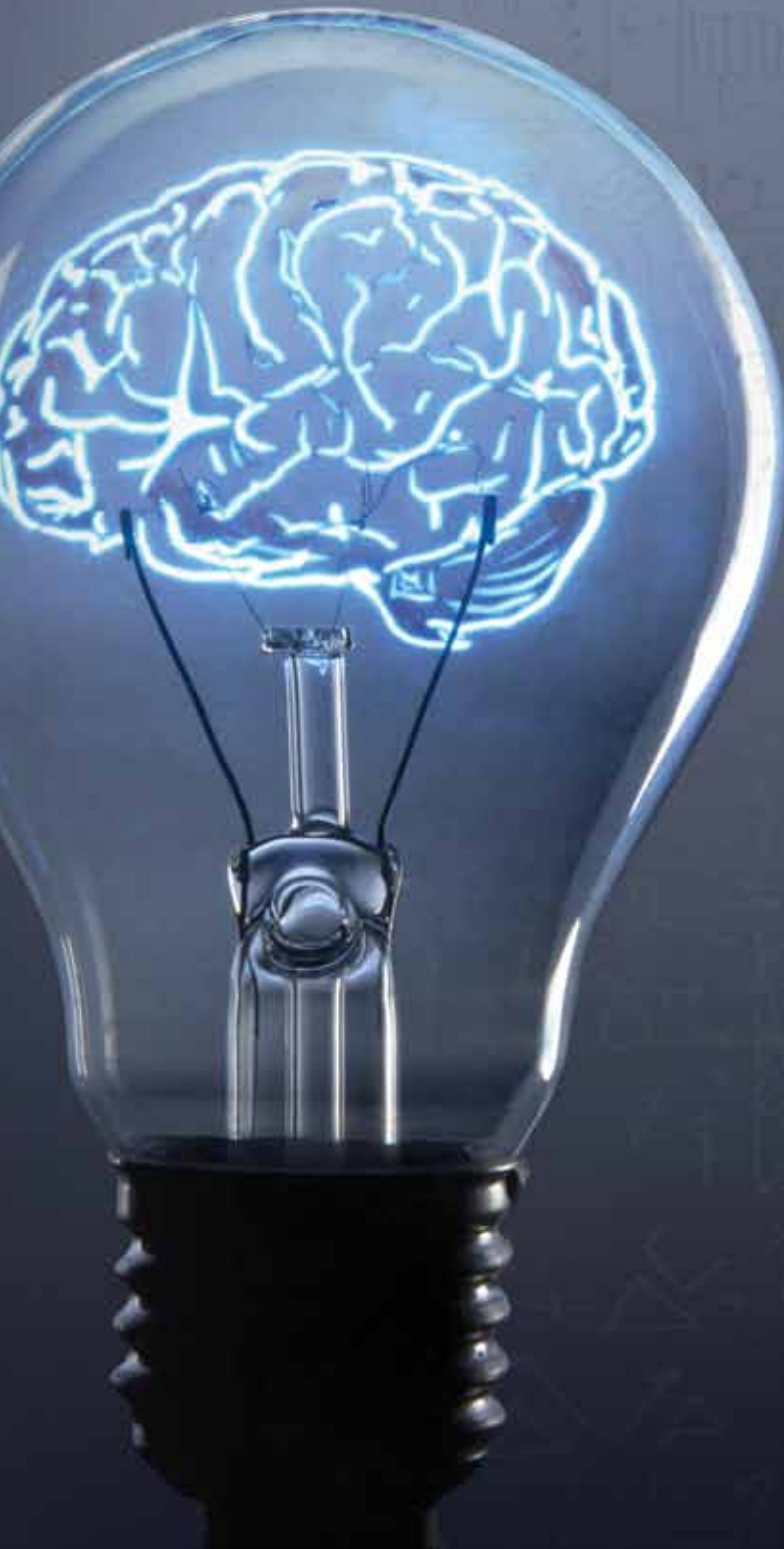


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TECHNOLOGY

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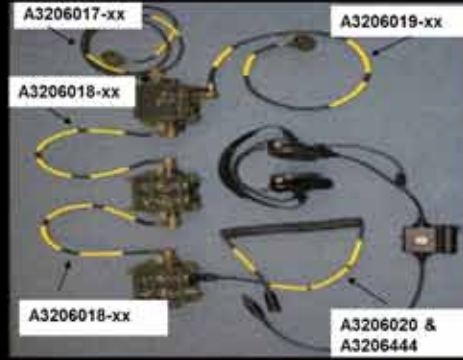


TOPIC:

INNOVATION

+ PLUS

INTERVIEW WITH
PATRICK O'NEILL
U.S. ARMY MATERIEL
COMMAND



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FEATURES

- 3 INNOVATE THE FUTURE**
Interview with Army Materiel Command Chief Technology Officer Patrick O'Neill
- 5 U.S. ARMY OPERATING CONCEPT**
The U.S. Army Operating Concept: Win in a Complex World presents a vision of future conflict.
- 6 THINKING CLEARLY ABOUT THE FUTURE OF WARFARE**
Army researchers use virtual reality to test Soldiers and discover influences on choices. BY LT. GEN. H.R. MCMASTER, ARCIC DIRECTOR
- 8 COUNTERING AERIAL THREATS**
Extended area protection and survivability counters aerial systems that could threaten Soldiers. BY ED LOPEZ, PICATINNY ARSENAL PUBLIC AFFAIRS
- 9 SOLAR CELL RESEARCH**
Researchers developed a tiny photovoltaic solar cell that resulted in a patent. BY NIKKI MONTGOMERY, AMRDEC PUBLIC AFFAIRS
- 10 DESIGNING EXOSKELETONS**
Army researcher's interest in robotics leads to innovative device. BY JOYCE P. BRAYBOY, ARL PUBLIC AFFAIRS
- 12 COMBAT RATION INFORMATION**
Combat rations database details MRE nutrition. BY BOB REINERT, USAG-NATICK PUBLIC AFFAIRS
- 13 ONE DISPLAY TO RULE THEM ALL**
Army engineers increase situational awareness for route control clearance teams. BY ALLISON BARROW, CERDEC PUBLIC AFFAIRS
- 14 CLEARING THE WAY**
M1271 Mine Clearing Vehicle, Interrogation Arm, and Explosive Hazard Pre-detonation Systems.
- 16 STUDYING NEW MOLECULE**
Chemical compounds known as metal-organic frameworks offer innovative chem-bio defense. BY ECBC PUBLIC AFFAIRS

- 17 FUTURE ARMY NANOSATELLITES**
Communication across great distances using existing UHF tactical radios made possible with tiny satellites. BY WILLIAM NORTON, TARDEC
- 18 MODULAR ACTIVE PROTECTION AND BETTER BUYING POWER 3.0**
Army researchers invest in future with acquisition philosophy. BY WILLIAM NORTON, TARDEC
- 20 REGENERATIVE MEDICINE**
Regenerative medicine technology treats complex traumatic injuries offering hope for burn victims. BY CRYSTA L MAYNARD, USAMRMC PUBLIC AFFAIRS
- 21 DOD SHOWCASES INNOVATION**
The Army demonstrated scientific, engineering efforts during the recent Department of Defense Lab Day. BY DAN LAFONTAINE, RDECOM PUBLIC AFFAIRS
- 22 TOP SCIENTISTS GATHER**
Mad Scientist Conference at Georgetown University brings together innovative thinkers that could one day augment Soldier capability. BY DAVID VERGUN, ARMY NEWS SERVICE
- 23 REVOLUTIONARY MORTAR SYSTEM**
New system to boost speed, accuracy, enhance Soldier safety. BY ERIC KOWAL AND ED LOPEZ, PICATINNY ARSENAL PUBLIC AFFAIRS
- 24 BETTER, SAFER BATTERIES**
Army researchers develop batteries that don't corrode. BY C. TODD LOPEZ, ARMY NEWS SERVICE
- 25 LASER TECHNOLOGY**
Army, Air Force take bomb disposal to new level with lasers. BY CARLOTTA MANEICE, AMRDEC PUBLIC AFFAIRS
- 28 MODEL BASED SYSTEMS ENGINEERING**
The use of modeling enhances our analytical capabilities. BY THOMAS HADUCH, DIRECTOR OF SYSTEMS ENGINEERING, RDECOM

ACRONYM GUIDE

AMC	U.S. Army Materiel Command
RDECOM	U.S. Army Research, Development and Engineering Command
ARL	Army Research Laboratory
ARDEC	Armament Research, Development and Engineering Center
AMRDEC	Aviation and Missile Research, Development and Engineering Center
CERDEC	Communications-Electronics Research, Development and Engineering Center
ECBC	Edgewood Chemical Biological Center
NSRDEC	Natick Soldier Research, Development and Engineering Center
TARDEC	Tank Automotive Research, Development and Engineering Center
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
ARCIC	Army Capabilities Integration Center
DARPA	Defense Advanced Research Projects Agency
DASA(R&T)	Deputy Assistant Secretary of the Army for Research and Technology
TRADOC	U.S. Army Training and Doctrine Command
USASMDC/ARSTRAT	U.S. Army Space and Missile Defense Command/Army Forces Strategic Command

DEPARTMENTS

- 1 ACRONYM GUIDE**
- 2 COMMANDER'S COLUMN**
- 5 STAND-TO**
- 25 NEWSBRIEFS**
- 28 SYSTEMS ENGINEERING**



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<http://armytechnology.armylive.dodlive.mil>

Army S&T drives innovation

By Maj. Gen. John F. Wharton
Commanding General, U.S. Army RDECOM

Scientists and engineers from across government, industry and academia are searching for technology solutions to bring empower American warfighters.

Innovation is the fuel for the Army of the future.

Army leaders have described how future Soldiers will “prevent conflict, shape security environments, and win wars while operating as part of our Joint Force and working with multiple partners” in the recently released Army Operating Concept, or AOC.

The AOC is our foundation, and it's driving our science and technology strategy.

“The AOC is a beginning point for the innovation we need to ensure that our Soldiers, leaders and teams are prepared to win in a complex world,” Army Chief of Staff Gen. Raymond T. Odierno wrote when he introduced the concept.

Innovation is critical for both the operational and institutional Army, he said.

The AOC points out that innovation is the result of “critical and creative thinking and the conversion of new ideas into valued outcomes.”

At the U.S. Army Research, Development and Engineering Command, we seek technological overmatch through strategic partnerships because we believe that collaboration breeds new ideas and will ensure our technological edge through the next several decades.

Many groundbreaking technological innovations in robotics, advanced computing, miniaturization and 3-D printing come from the commercial sector. We cannot assume that the

Department of Defense will be the sole source of key breakthrough technologies. In our search for innovative solutions, we continually reach out to our industry partners as we seek to maintain our technological edge.

We have 734 S&T tasks for which we are funded from the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology, better known as ASA(ALT). We've organized these tasks into about 50 categories and aligned them to the five key technology imperatives from U.S. Army Training and Doctrine Command:

- Grow Adaptive Army Leaders, Optimize Human Performance
- Maximize Demand Reduction and Improve Reliability
- Maintain Overmatch
- Enhance Expeditionary Capabilities
- Continuously Upgrade, Protect and Simplify the Network

Synchronizing our efforts gives visibility to these imperatives. At the same time, we're comparing this with the Army Warfighting Challenges. This alignment gives us the ability to prioritize.

We recognize there are no “silver bullet” technological solutions. It's not about the technology or device but about enabling the Soldier. Our efforts incorporate innovative solutions to fill technology gaps and make our Soldiers safer, stronger and more situationally aware of their environments.

Innovation will ensure the United States



Maj. Gen. John F. Wharton
Commanding General
RDECOM

Bio: <http://www.army.mil/article/134110/>

maintains its technological edge. It counters challenges to our competitive advantages and focuses our investments while creating options for future leaders. The Army needs innovative methods to develop technologies that will optimize the capabilities of smaller units by increasing battlefield intuition, military judgment and decision making.

Across RDECOM, I applaud the research and development innovations that lead to technological advancements. Whether it is new sensors, better batteries, or stronger materials for armor protection, the goal is the same. We innovate because it's all about supporting our Soldiers with the best possible technologies to help them accomplish their missions.

ARMY TECHNOLOGY

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Innovate the Future

INTERVIEW WITH ARMY MATERIEL COMMAND CHIEF TECHNOLOGY OFFICER PATRICK O'NEILL



Patrick J. O'Neill became the chief technology officer for the U.S. Army Materiel Command April 5, 2015, at Redstone Arsenal, Alabama. Previously, he was the U.S. Army Materiel Systems Analysis Activity technical director at Aberdeen Proving Ground, Maryland. He holds a master of science in national resource strategy from the Industrial College of the Armed Forces, a master of science in computer science from Johns Hopkins University and a bachelor of science in mathematics and computer science (double major) from Loyola University. He has published numerous AMSAA technical reports and presented numerous papers in national and international operations research and military forums. He was appointed to the Senior Executive Service in March 2011.



Army Technology: What is your vision for the Army of the future, and what role will technology play?

O'Neill: We should try to be the best. To enable that, I encourage us to challenge the status quo, empower and encourage innovation and professional growth, navigate our thinking, and infuse industry and academia in our plans.

As we think about the deep future, we should work closely with industry and academia to identify potential technologies early and to identify ways to support them for use in existing systems. How should we think differently? This will allow us to rapidly incorporate them in systems still under development.

The challenges the Army faces, especially with the continued competition for resources, will be daunting. Our chief of staff, Gen. Raymond T. Odierno, characterized it well by describing that the "velocity of instability is increasing and protecting technology is very critical."

Army Technology: You've said that we should focus on being more efficient and effective. What is the best way to accomplish this?

O'Neill: It is important, especially with the threat of sequestration, to acquire technologies in a cost effective and efficient manner through joint collaboration and leveraging of investment dollars. It is critically

important that the Army collaborate with other services, industry and academia to identify potential technologies early and to identify ways to integrate those technologies into the Soldiers' kit.

The Defense Innovation Initiative is a new approach to allow new thinking focused on threats and challenges to our military and technological superiority. At the center of Force 2025 and Beyond will be the ability to provide technologies for supporting future operations and to streamline operational processes to produce a more adaptable, agile and effective Army. I believe the new Defense Innovation Unit Experimental in Silicon Valley will help create the presence we need in order to best identify and speed the technologies of tomorrow.

Army Technology: How does AMC partner with the Army's S&T community across industry academia and the government? How important are these partnerships?

O'Neill: Technological advancements will have a greater dependence on international industry and academic partnerships. We have a responsibility to our international partners. We are not alone in this investment. The Army finds itself in a familiar situation, facing a defense budget deficit and a strategic landscape that continues to advance. The Army, regardless of conflicts, must collaborate with industry and academia. We are focused on thinking collectively about the Army and AMC's future.

Army Technology: The Army Operating Concept says, "The Army will foster a culture of innovation to accomplish Force 2025. Technological innovations represent one aspect of innovation. How will we build such a culture?"

O'Neill: Since his swearing-in earlier this year, Secretary of Defense Ash Carter has reminded all of us that we need to be open to change and, as he puts it, "to think outside of the five-sided box."

Part of the Defense Innovation Initiative is a long-range R&D Development Plan. How can we share technology advances among the services? This is important as the Army strives to stay competitive and to stay ahead of threats. All of this starts with our people. They are our most important asset. It's up to us to establish the technical vision. We've got what it takes to meet the demands of the future. In addition, companies with innovative technologies are encouraged to collaborate with the Army and find events to showcase their technologies.

Army Technology: How optimistic are you about Army modernization efforts in light of the current budgetary environment?

O'Neill: The Army is shrinking in size from the Operation Enduring Freedom/Operation Iraqi Freedom peak of 565,000 to currently 490,000, on the way to 450,000 Soldiers. The Army must balance between modernization and all its other obligations to maintain a capable force able to prevent, shape and win in any engagement. I'm optimistic because S&T funding is being protected by our 535-person board of directors, while acquisition has been reduced since Fiscal Year 2012. We continue to invest appropriately in S&T.

Army Technology: How would you inspire Army researchers, scientists and engineers to innovate future technology solutions?

O'Neill: The Army has the brightest scientists and engineers in the world, and we will find a way to accommodate the future operational needs of the force. Throughout history, Army scientists and engineers have provided a benefit to society. The AMC team includes more than 13,000 scientists and engineers inside RDECOM.

3-D printing holds significant capabilities for industry and Soldiers. 3-D printing has been adopted by industry as an enabler for the next generation of products and systems. 3-D printing is a great example of those efforts, and it offers incredible potential.

To maintain dominance in light of a future of unknown and often rapid changes, the Army must posture itself to proactively innovate, to efficiently identify technologies, to develop solutions and to deliver sustainable capabilities to the force.

By 2025, the Army must operate differently, enable differently and organize differently to maintain overmatch and to set the conditions for fundamental long-term change. It is all about the Soldier.

Army Technology: What is the vision for your office?

O'Neill: Our vision is that innovation matters, for our Soldiers and the world. The fact that AMC has a CTO reflects the importance of the Army's S&T mission. Working with RDECOM, my office plays a very significant role in shaping the way S&T impacts the Army Force of 2025 and Beyond.

We are the catalyst for the future, redefining and strengthening AMC's voice to deliver new capabilities to embrace and execute its role as the Army's leader in S&T. The CTO will be a strong voice as we continue to pioneer new technologies that are critical to meeting our defense needs. We can overcome the rising "velocity of instability" by continuing to push hard, do the right things, be effective and efficient ... all in support of the Soldier. ■

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The U.S. Army Operating Concept

WHAT IS IT?

The U.S. Army Operating Concept: Win in a Complex World presents a vision of future conflict that drives how the Army must change to ensure future forces are prepared to prevent conflict, shape the security environment, and win wars. The concept highlights that the future operational environment is not only unknown, but unknowable and constantly changing. To win in this complex world, Army forces must provide the Joint Force with multiple options, integrate the efforts of multiple partners, operate across multiple domains, and present our enemies with multiple dilemmas. The AOC is the start point for developing the future force, and provides the intellectual foundation for a comprehensive strategy to change the Army and guide capability development.



WHAT HAS THE ARMY DONE?

Released in October 2014 by the Army Capabilities Integration Center, part of the U.S. Training and Doctrine Command, the AOC builds on lessons learned over 13 years of conflict. The concept depicts Army forces as essential components of joint operations to create sustainable political outcomes while defeating enemies and adversaries who will challenge U.S. advantages in all domains: land, air, maritime, space, and cyberspace. The release of the concept has encouraged discussion and further learning, and established a starting point for future force development.

WHY IS THIS IMPORTANT TO THE ARMY?

The AOC describes how future Army forces will operate to protect U.S. national interests across a range of military operations. The concept is grounded in a vision of future armed conflict that considers national defense strategy, missions, emerging operational environments, advances in technology, and anticipated enemy, threat, and adversary capabilities. Conducting operations consistent with tenets found in the AOC allows forces to achieve operational overmatch and seize, retain, and exploit the initiative.

The AOC adds "set the theater" and "shape the security environment" as core competencies to emphasize the Army's foundational role in future conflict along with "special operations" to highlight the dynamic combinations of conventional and unconventional forces the Army provides. Ultimately, the AOC describes how Army forces will fight, what they must achieve, and how they will address future challenges.

WHAT CONTINUED EFFORTS DOES THE ARMY HAVE PLANNED FOR THE FUTURE?

This AOC will guide the development of Functional Concepts which detail how future Army forces will conduct operations across specific functional areas. The Army will integrate force modernization efforts while collaborating with key stakeholders using the Army Warfighting Challenges analytical framework provided in the AOC. Furthermore, the Army will use the AOC as the intellectual foundation for its comprehensive future modernization strategy. ■



FOCUS QUOTE

“We define innovation in the Army Operating Concept as really our ability to turn ideas into valued outcomes and then also to be able to do that in a way that we stay ahead of determined, and increasingly capable enemies.”

— Lt. Gen. H.R. McMaster,
Deputy Commanding
General, Futures /
Director, Army Capabilities
Integration Center, U.S.
Army Training and Doctrine
Command



For more on the U.S.
Army Operating
Concept: [http://www.
army.mil/standto/
archive_2014-12-22/](http://www.army.mil/standto/archive_2014-12-22/)

Thinking Clearly About the **FUTURE OF WARFARE**

Army researchers use virtual reality to test Soldiers and discover influences on choices **BY LT. GEN. H.R. MCMASTER, U.S. ARMY**

Anticipating the demands of future armed conflict requires an understanding of continuities in the nature of war as well as an appreciation for changes in the character for armed conflict. —The U.S. Army Operating Concept

Expert knowledge is a pillar of our military profession, and the ability to think clearly about war is fundamental to developing expert knowledge across a career of service. Junior leaders must understand war to explain to their Soldiers how their unit's actions contribute to the accomplishment of campaign objectives. Senior officers draw on their understanding of war to provide the best military advice to civilian leaders. Every Army leader uses his or her vision of future conflict as

a basis for how he or she trains soldiers and units. Every commander understands, visualizes, describes, directs, leads and assesses operations based, in part, on his or her understanding of continuities in the nature of war and of changes in the character of warfare.

A failure to understand war through a consideration of continuity and change risks what nineteenth century Prussian philosopher Carl von Clausewitz warned against: regarding war as "something

autonomous" rather than "an instrument of policy," misunderstanding "the kind of war on which we are embarking," and trying to turn war into "something that is alien to its nature."

In recent years, many of the difficulties encountered in strategic decision making, operational planning, training and force development stemmed from neglect of continuities in the nature of war. The best way to guard against the tendency to try to turn war into something alien to its nature is to understand four key continuities in the nature of war and how the U.S. experience in Afghanistan and Iraq validated their importance.

In the aftermath of the 1991 Gulf War, defense

thinking was dominated by theories that considered military operations as ends in and of themselves rather than essential components of campaigns that integrate the broad range of efforts necessary to achieve campaign objectives. Advocates of what became the orthodoxy of the "revolution in military affairs," or RMA, predicted that advances in surveillance, communications, and information technologies, combined with precision strike weapons, would overwhelm any opponent and deliver fast, cheap, and efficient victories. War was reduced to a targeting exercise. These conceits complicated efforts in Afghanistan and Iraq as unrealistic and underdeveloped war plans confronted unanticipated and underappreciated political realities.





WAR IS UNCERTAIN

Although advances in technology will continue to influence the character of warfare, the effect of technologies on land are often not as great as in other domains due to geography, the interaction with adaptive enemies, the presence of noncombatants, and other complexities associated with war's continuities. —The U.S. Army Operating Concept

The dominant assumption of the RMA was that knowledge would be the key to victory in future war. Near-perfect intelligence would enable precise military operations that, in turn, would deliver rapid victory. In Afghanistan and Iraq, planning based on linear projections did not anticipate enemy adaptations or the evolution of those conflicts in ways that were difficult to predict at the outset.

Army professionals recognize war's uncertainty because they are sensitive to war's political and human aspects, and they know from experience and history that war always involves a continuous interaction with determined, adaptive enemies.

The Army Operating Concept, or AOC, emphasizes the tenet of adaptability and the need for leaders to "assess the situation continuously, develop innovative solutions to problems, and remain mentally and physically agile to capitalize on opportunities." The AOC also redefines the tenet of depth to

highlight the need to "think ahead in time and determine how to connect tactical and operational objectives to strategic goals."

TECHNOLOGY

“The U.S. Army's differential advantage over enemies derives, in part, from the integration of advanced technologies with skilled soldiers and well-trained teams.”

— **The U.S. Army Operating Concept**

Science and technology will continue to influence the character of warfare. While the U.S. Army differential advantages over potential enemies will continue to depend in large measure on advanced technology, winning in a complex world requires powerful combinations of leadership, skilled soldiers, well-trained units and technology. There are no technological silver bullets. The Army must integrate new technological capabilities with complementary changes in doctrine, organization, training, leader development, personnel and other elements of combat effectiveness.

Army technological development emphasizes the need for all formations to possess the appropriate combination of mobility, protection and lethality. And the Army places Soldiers at the center of that effort, pursuing "advances in human sciences for cognitive, social, and physical development"

while fitting weapons and machines to soldiers and units rather than the other way around.

OUR ARMY IS INNOVATING UNDER FORCE 2025

Maneuvers, "the physical (experimentation, evaluations, exercises, modeling, simulations, and war games) and intellectual (studies, analysis, concept, and capabilities development) activities that help leaders integrate future capabilities and develop interim solutions to warfighting challenges."

Successful innovation will require focused and sustained collaboration among Army professionals committed to reading, thinking and learning about the problem of future armed conflict, and

determining what capabilities our Army and joint force must develop to win in a complex world. ■

Editor's note: This article is an excerpt from "Continuity and Change," a March/April 2015 Military Review article by Lt. Gen. H. R. McMaster. McMaster is the deputy commanding general, Futures, U.S. Army Training and Doctrine Command, and director of the Army Capabilities Integration Center. He has a doctorate in military history from the University of North Carolina at Chapel Hill. McMaster has served as a U.S. Army War College Fellow at the Hoover Institution on War, Revolution, and Peace and as a senior consulting fellow at the International Institute of Strategic Studies in London.

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Countering Aerial Threats

Extended area protection and survivability counters aerial systems that could threaten Soldiers BY ED LOPEZ, PICATINNY ARSENAL PUBLIC AFFAIRS

As drone technology gains greater public attention, along with its potential for hostile action against American targets, U.S. Army engineers are seeking to adapt ongoing research to counter aerial systems that could threaten Soldiers.

At Picatinny Arsenal, the Extended Area Protection and Survivability Integrated Demonstration, or EAPS ID, began as an Army Technology Objective program. The goal was to develop and demonstrate technology that could support a gun-based solution to counter rockets, artillery and mortars, or C-RAM.

Research into enhanced C-RAM technology had the goal of extending the range and probability of success against the incoming threat.

"The smaller and smaller the protective area, the more efficient the gun systems become compared to missiles," said Manfredi Luciano, the project officer for the system. "You don't need as many, and the gun system has certain logistics advantages."

Ongoing technology aimed at countering rockets, artillery and mortars could be used to defend against Unmanned Aerial Systems, or UAS, he said.

The world's inventory of unmanned aircraft systems has grown from about 20 system types and 800 aircraft in 1999, to more than 200 types and about 10,000 unmanned aircraft in 2010, said Nancy Elliott, a spokeswoman with the U.S. Army's Fires Center of Excellence at Fort Sill, Oklahoma.

Although a missile-based C-RAM defense system has been selected as the technical approach

for the Indirect Fire Protection Capability Increment 2 Intercept Program of Record, the gun alternative has continued to mature for other potential applications.

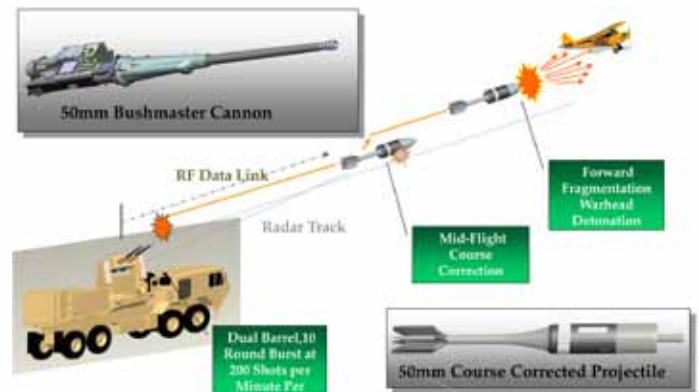
Luciano and his team, working on enhanced area protection and survivability, tested an integrated system April 22 by shooting down a class 2 unmanned aerial system using command guidance and command warhead detonation at Yuma Proving Ground, Arizona. Funding for development and testing was provided by the ARDEC Technology Office.

The EAPS ARDEC gun alternative envisions a 50mm cannon to launch command guided interceptors. The system uses a precision tracking radar interferometer as a sensor, a fire control computer, and a radio frequency transmitter and receiver to launch the projectile into an engagement "basket."

"In order to minimize the electronics on board the interceptor and to make it cheaper, all the 'smarts' are basically done on the ground station," Luciano said. "The computations are done on the ground, and the radio frequency sends the information up to the round."

The area-protection systems tracks both the incoming threat and interceptor, then computes an ideal trajectory correction for the interceptor to maximize probability of mission success. A thruster on the interceptor/projectile is used for course correction. The ground station uplinks the maneuver and detonation commands, while receiving downlinked assessment data.

The interceptor takes the commands and computes the roll



The operational concept behind the Enhanced Area Protection and Survivability technology is to have a 50mm course-corrected projectile intercept an incoming threat. The warhead has a tantalum-tungsten alloy liner to form forward propelled penetrators for defeat of rockets, artillery and mortars, while steel-body fragments are designed to counter unmanned aerial systems. The technology is in various stages of development and testing.

orientation and time to execute thruster and warhead detonation. The warhead has a tantalum-tungsten alloy liner to form forward propelled penetrators for defeat of C-RAM targets, and steel body fragments to counter unmanned aerial systems.

Researchers performed the recent test with the UAS flying a surveillance-type track and engaging on the approach path leg. The airplane fell precipitously from its flight. Demonstrating a "proof-of-principle" that direct fire, command-guided ammunition can intercept and negate aerial threats, Luciano said.

Technologies from the EAPS gun alternative Army Technology Objective may potentially be used for both Army and Navy air defense systems, he added.

Luciano said that during another upcoming test, the engineers would try to intercept and destroy an unmanned aerial system under a more difficult engagement scenario. ■

Editor's note: Industry works closely with Army researchers and engineers to develop technology solutions. Technovative Applications in Brea, California, designed, fabricated and operated the EAPS fire-control radar interferometer. Radar interferometers use multiple receive antennas to enhance angular measurements for centimeter tracking accuracy. Design of the 50mm cartridge/interceptor was a collaborative effort between ARDEC engineers and Orbital ATK, Armament Systems Division in Plymouth, Minnesota. Interceptors were assembled by Orbital ATK and warheads by Aerojet Rocketdyne in Sacramento, California. The fire-control algorithm was a collaborative effort by the various subject matter experts but led and written by Propagation Research Associates, Inc. in Atlanta. ARDEC's Munitions Systems and Technology Directorate led the EAPS Integrated Product Team.

Solar Cell Research

Researchers develop tiny photovoltaic solar cell that results in patent

BY NIKKI MONTGOMERY, AMRDEC PUBLIC AFFAIRS

U.S. Army researchers have developed a tiny photovoltaic solar cell for the conversion of light energy into electrical energy that it resulted in a patent.

The patent reveals a new kind of photovoltaic solar cell with significantly reduced size and cost compared with current solar cells.

Dr. Michael Scalora, a research physicist at the U.S. Army Aviation and Missile Research, Development and Engineering Center at Redstone Arsenal, Alabama, described the invention as a “breakthrough,” which he hopes will be the basis for further technological progress.

Scalora is a co-inventor of the solar cell.

“Low-cost, compact, flexible and efficient solar cells are destined to impact all sorts of Department of Defense applications, as lightweight solar panels will eventually power all kinds of equipment, particularly in remote, inaccessible areas,” he said. “The key to the development of efficient, compact solar cells are advances in nanotechnology, nano-fabrication techniques and thin-film production.

“Current solar cells based on single crystal (pure) silicon have advanced significantly over the years.”

A photovoltaic, or PV, solar cell is a specialized semiconductor diode that converts visible light into a direct current. The PV cell allows solar light to be absorbed efficiently by a material and then converted into charge carriers that generate an electrical current, known as a photocurrent.

“The process that led to our patent was inaugurated in the late 1990s when we began a detailed study of the optical properties of noble metals like silver, gold and copper,” Scalora said. “Our invention inserts layers of metals like silver and gold between the various semiconductor layers resulting in a combined thickness of only a few hundred nanometers.”

A piece of paper is about 100,000 nanometers thick.

“This is a great example of one of our programs that transitioned to the military and private sector,” said Wayne Davenport, Optical Sciences Function Chief of the Weapons Development and Integration Directorate and Scalora’s supervisor. “Though the foundational effort began in the 1990s, it has found applications over 20 years later.”

The next generation of solar cells has begun to address costs, materials and flexibility problems, in addition to reducing the thickness of the PV cell. The newly designed, multilayer stack has dramatically reduced the size of a PV cell, about 1,000 times thinner than that of the previous 100 to 200 microns, which was about the size of a grain of sand.

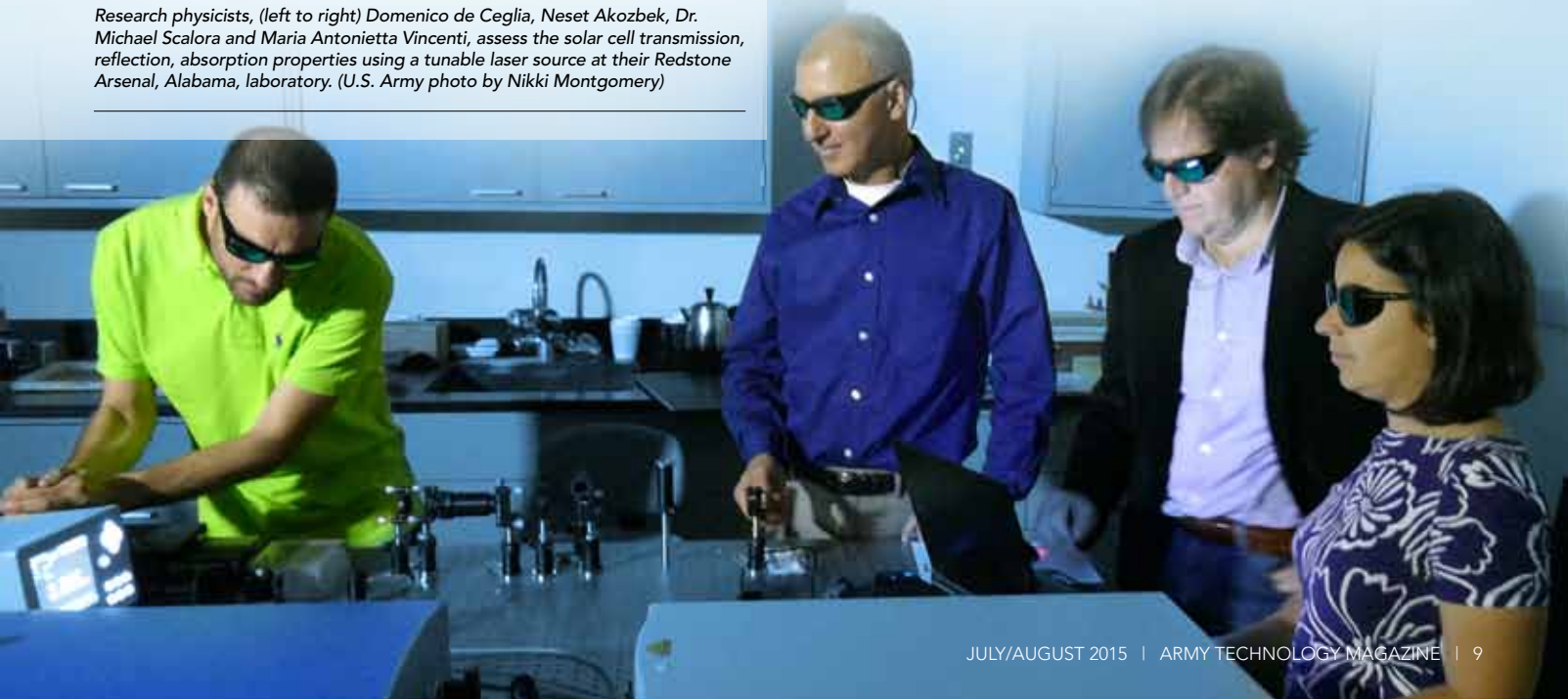
The inventors designed the cell to overcome current solar panel problems such as wear out, damage and stress introduced to the structure by heating. Damage and heating in a solar panel is produced by absorption of the high content of ultraviolet and infrared radiation from the sun.

A critical problem with radiation is the mismatch between the broad wavelength band available in sunlight and the narrow wavelength band associated with semiconductor energy bandgap. If light was allowed to enter the cell, this mismatch would cause a loss of power. By using the photonic bandgap approach developed in this invention, solar cells will operate more efficiently than presently possible.

The inventors of photonic bandgap solar cells altered the multilayer stack of the solar cell using geometrical parameters and optical properties of noble metals allowing direct control of energy absorption, reflection and transmission spectra.

“As with many basic research projects, the near-term benefits are sometimes yet undefined but are clearly worth the investment,” Davenport said. “The Army’s research laboratories at AMRDEC continue a legacy of high quality research projects and I expect to see many more of these type projects transition to the Warfighter in the future.” ■

Research physicists, (left to right) Domenico de Ceglia, Neset Akozbek, Dr. Michael Scalora and Maria Antonietta Vincenti, assess the solar cell transmission, reflection, absorption properties using a tunable laser source at their Redstone Arsenal, Alabama, laboratory. (U.S. Army photo by Nikki Montgomery)



DESIGNING EXOSKELETONS

Army researcher's interest in robotics leads to innovative device

BY JOYCE P. BRAYBOY, ARL PUBLIC AFFAIRS

Dan Baechle had a childhood fascination with robotics and exoskeletons since he first saw Caterpillar's Power Loader full-body exoskeleton from Aliens. Robotic exoskeletons have been a science fiction theme and an engineering feat since the 1960s.

Practical design techniques that allow a fictional character to be stronger, more powerful or more functional intrigues engineers toward simplicity in futuristic innovation.

At the U.S. Army Research Laboratory, or ARL, Baechle, a mechanical engineer, is testing MAXFAS, a mechatronic arm exoskeleton, which is designed so that it could be used to train new Soldiers to reach shooting proficiency faster.

The near-future vision for the developmental test system is that it would be a training device

to help new recruits with novice marksmanship skills and generally help increase combat arms shooting performance on the battlefield.

"Soldiers need to be able to aim and shoot accurately and quickly in the chaos of the battlefield," Baechle said. "Training with MAXFAS could improve Soldiers' accuracy, and reduce current time and ammunition requirements in basic training."

The problem he wants to correct is the same as the familiar effect that happens when someone aims a laser pointer at arm's length toward a board on the other side of the room, and notices a slight, but constant movement of the laser light on the board. The initial experiments showed that after subjects wore MAXFAS and then performed a shooting trial, the tremor

that causes this type of shake was lessened, even after removing the device, he said.

Baechle is on a team that specializes in using lightweight materials to enhance the performance of soldiers and their equipment, said Eric Wetzel, team leader of the Multifunctional Materials Team at ARL.

"At ARL we strive to develop new approaches to challenging Army problems, and are especially attracted to high risk projects that could drastically improve soldier capabilities. Dan's work demonstrates that the integration of advanced materials, robotics, and control algorithms can help address a critical Army requirement - shooting proficiency - in an unconventional way."

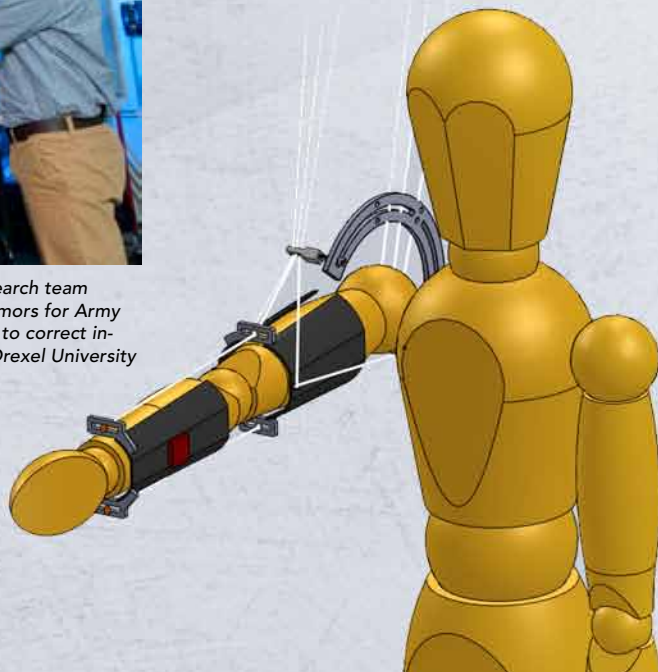
MAXFAS is modeled from a robotic device to train arm motion of stroke victims at the University of Delaware. Baechle wanted to make the design functional for marksmanship and used carbon fiber to make the exoskeleton lighter. He envisioned a device that would stabilize its user's arm during the shooting cycle either on-the-spot or to train for long-term proficiency, he said.

"The Soldier is already wearing a lot of



Above: Dan Baechle from the U.S. Army Research Laboratory Multifunctional Materials research team has created a laboratory prototype of a device he designed to sense and damp out arm tremors for Army marksmanship training. His concept demonstrates the simple, control scheme has potential to correct involuntary tremors in shooting. Research Assistant Sean Averill, an incoming sophomore at Drexel University who majors in mechanical engineering, has been working with Baechle on the project for the last seven weeks. (U.S. Army photos by Doug LaFon)

Right: Computer simulated modeling of the MAXFAS cables that attach from behind to enable the red sensor to feel and adjust the slightest of arm movement help the team communicate to human sciences experts the concept of how they would like to improve shooting proficiency.



weight on missions. I figure with a carbon fiber exoskeleton, I could add a big performance benefit without much additional weight," Baechle said.

Baechle mounted motors for the MAXFAS cable-driven arm behind the wearer, which pull the cables that are attached to arm braces, as a puppeteer would. The braces are made from carbon fiber, and add very little weight to the arm. Sensors on the braces feel the involuntary tremor in the arm and send signals to the motors to correct it, but do not restrict voluntary motion, he said.

His idea is a crossover between materials and human sciences. As he looks forward to refine his initial proof-of-concept results, Baechle said he plans to bring together experts in both fields, as well as young scientists.

Sean Averill, a research assistant from Drexel University who is working with Baechle for six months of real-world experience, assists on the MAXFAS technology with tasks like getting motion streaming into the lab view, wiring and designing the systems security latch.

"I get an end goal to accomplish and the freedom to design it," Averill said.

MAXFAS has passed its first step in showing potential to correct arm tremors in the



laboratory.

"You could have the greatest proof of concept, but what is important is demonstrating the value of the device to those with Army mission requirements," Baechle said.

Baechle believes the project he has been working on for the last year has a chance, because fatigue, involuntary tremors in the arm and difficult situations like shooting under fire or shooting on the move will continue to degrade shooting performance in Soldiers even as more

advanced weapons technology emerges.

"My vision is that one day, a more mature version of MAXFAS could be used to improve aim on the battlefield despite any adverse conditions," he said.

What the ARL team has produced in the laboratory hasn't quite caught up with the science fiction exoskeletons we see in movies like Iron Man, but, Baechle said, "In science, we are making great progress toward making science fiction a reality." ■

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COMBAT RATION INFORMATION

Combat rations database allows Soldiers to learn about meals, ready-to-eat nutrition

BY BOB REINERT, USAG-NATICK PUBLIC AFFAIRS

When Soldiers rip open meals, ready-to-eat, also known as MRE, in a combat zone, most people probably are thinking more about flavor and filling their stomachs than about the nutrition.

However, that does not mean nutrition is not important. The new online combat rations database, or ComRaD, formally launched earlier this month by the Department of Defense's Human Performance Resource Center, or HPRC, provides warfighters, military dietitians, food service officers and leaders the opportunity to learn more about the nutritional value of what is inside those packages.

ComRaD is the result of a collaborative effort between HPRC, the Natick Soldier Research, Development and Engineering Center, also known as NSRDEC, and the U.S. Army Research Institute of Environmental Medicine, or USARIEM, at Natick Soldier Systems Center. The database contains nutrition information about the MRE, First Strike Ration, Meal, Cold Weather, and Food Packet, Long Range Patrol.

Before ComRaD, military customers needed to contact experts

at NSRDEC's Combat Feeding Directorate, or CFD, to obtain accurate nutritional information. The lack of public access to this information has left customers to obtain nutritional information from alternate sources that are sometimes unreliable and inaccurate.

Today's increased emphasis on performance nutrition in the military provided the boost needed to get the website up and running.

"Military dietitians expressed a need for publicly available nutrition information that could be used to help educate warfighters on how to properly fuel themselves before a mission, during a mission and post mission," said Julie Smith, senior food technologist with the CFD.

In the past, one had to rely on the nutrition fact labels provided on the food component packages to have any idea what was in them. Holly McClung, a research dietitian at USARIEM, said those labels are not always accurate.

"That's why the website's so important," McClung said. "That's where we want the warfighter and the dietitians to go to, because we know that the nutrition info is accurate and up to date."

How does McClung know this?

"The nutrition information that feeds into the database comes from actual chemical analysis of the food component," McClung said.

"That's ... where USARIEM came in. We funded the chemical analysis of food components in the 24-menu MRE and other ration lines, which is difficult, expensive and time consuming.

"This is why it's taken us so long to complete the process. At this website, the user will be able to get nutrition on every individual component, the composition of complete ration lines, and individual MRE menus that are 100-percent chemically analyzed, so we feel confident in the nutritional data."

A quick look at the website would seem to reveal that warfighters are consuming too many calories and that their intake of ingredients such as sodium is too high. The numbers are deceiving, however.

"A civilian might look at what the energy needs are for a warfighter, or look at how much is provided

in a ration, and think the rations are providing too many calories and/or fat, et cetera," McClung said. "What they have to realize is that the rations are constructed to meet the energy and nutritional needs of physically active warfighters. So, while there may be excessive energy available in the ration for a Soldier sitting at a desk, the ration may just meet the requirements of a physically active Soldier (who is) on (his or her) feet for a 12-hour patrol.

The ComRaD website will change over time, Smith said.

"We're already working on ... additional features to the website that will provide ComRaD users with Unitized Group Ration nutrition information, as well as a cart feature that will allow users to track what they have eaten by adding and removing ration components in order to view their overall daily nutritional intake.

"I think that it will be an evolving website [with] future improvements based upon the feedback that we get from users," said Smith, adding "which is really going to be invaluable." ■

A Soldier digs into a First Strike Ration in the mountains of Afghanistan. Nutritional information about the First Strike Ration and other individual rations is now available at the online combat rations database. (U.S. Army photo by Michael Stepien)

ONE DISPLAY TO RULE THEM ALL

Army engineers increase situational awareness for route clearance teams BY ALLISON BARROW, CERDEC PUBLIC AFFAIRS

U.S. Army researchers are reducing the cognitive load on Soldiers by streamlining critical surveillance functions as part of counter-explosive, route clearance missions inside the Medium Mine Protected Vehicle, known as MMPV.

By collapsing the multiple video displays within the vehicle into a single touchscreen display, the U.S. Army Communications-Electronics Research, Development and Engineering Center, or CERDEC, in partnership with Product Manager Assured Mobility Systems, set out to increase situational awareness and operator efficiency, while decreasing size, weight and power, or SWaP.

Because of the way the counter-IED threat has evolved, there are an increased number of individual systems inside the MMPV compartments, such as imaging sensors, weapon systems and communications equipment, said Sean Jellish, CERDEC Night Vision and Electronic Sensors Directorate Multifunction Video Display lead engineer.

"In the past we were at war, and everyone was trying to get new systems into the field," Jellish said. "The quickest way to do that was everybody having their own equipment thrown out there."

CERDEC engineers developed the MVD in response to a requirement from the product manager for a common display to view and control all vehicle enablers

simultaneously at all Counter Radio-Controlled Improved Explosive Devices Electronic Warfare, or CREW, system stations inside the vehicle.

Soldiers have had to operate each system independently and on different displays, which led to issues with integration, capability growth and seamless operations. Full-motion video could also only be displayed at one Soldier's dedicated display, Jellish said.

"Every seat in the vehicle has multiple displays in front of it and the Soldier in that seat is the one person that operates that sensor," he said. "So you have all these different stove-piped sensor systems there, and it's super cumbersome to deal with all those systems for the Soldier."

"We started by putting a request for information out ... and jointly we also had them [NVESD] continue working a system demonstrator for us themselves," said Brian Wilson, Systems Integration team leader for the Tank Automotive Research, Development and Engineering Center's Route Clearance Vehicle Team, which is working with the product manager.

"We were so impressed with what they were doing from the system demonstrator that we took a hard approach to say, 'Well we'd be able to keep this software in-house with the government and that would be the best case scenario because we'd have control

of it and it wouldn't be tied to a particular contractor,'" Wilson said.

NVESD engineers quickly adapted their previous research with a Multisensor Graphical User Interface, which takes a wide field of view sensor and uses it to control a narrow field of view, highly magnified sensor.



Top: A plugin demonstrates slew-to-cue functionality, enabling efficient use of high magnification sensors for inspecting areas of interest on-the-move. (U.S. Army photos)

Above: The graphical user interface establishes a common monitor and interface to view and operate many simultaneous real-time video feeds.



CLEARING THE WAY

M1271 Mine Clearing Vehicle, Interrogation Arm, and Explosive Hazard Pre-detonation Systems

MISSION

Provides blast-protected platforms capable of locating, interrogating, and classifying suspected explosive hazards, including improvised explosive devices.



The U.S. Army's Medium Mine Protected Vehicle Type II performs a roadside threat interrogation activity. (U.S. Army photo)

By bringing all the sensor systems together in one unified display, each Soldier has access to all of them at each operator station, increasing situational awareness and operator efficiency.

If one Soldier sees something on the monitor, other Soldiers can switch to that sensor's view on their displays. In the past, only one Soldier would be able to look at that sensor system's view. The

system can also record the images and video captured while in route, Jellish said.

"This is going to be a major benefit to the user," Wilson said. "Every single Soldier will be able to see what is on the enabler because you have the ability to toggle between all the different video feeds that are on that truck. So that is going to increase, from an operational standpoint, the time on target for

route clearance missions. It's going to improve communication and it also starts to get rid of the multiple screens."

The innovative system also improves training for Soldiers operating the vehicle as they will only have to learn to operate a single user interface.

"It improves operator efficiency, in that you get rid of the over-abundance of displays in front of them,"



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DESCRIPTION

The MPVF consists of the Medium Mine Protected Vehicle Type I and II, (Type II includes an Interrogation Arm) the Vehicle Mounted Mine Detection system, and the Mine Protected Clearance Vehicle. All are blast-protected as each of the systems in the MPVF has a blast-deflecting, V-shaped hull, and each conducts a specific mission. The Mine Clearing Vehicle is used for area clearance operations. Explosive Hazard Pre-detonation systems are enablers used on the MMPV Type II, the VMMD, and the MPCV.

The MMPV command and control vehicle is adaptable to a wide range of security and force protection activities. The MMPV Type I, known as the Panther, will support Explosive Ordnance Disposal Companies as the rapid response vehicle. The Panther will also support Chemical Biological Response Teams. The MMPV Type II will support Engineer Units in route and area clearance operations.

The VMMD is a vehicle-mounted mine-detection and lane-proofing system capable of finding and marking metallic explosive hazards, including metallic-encased IEDs. A system consists of two mine detection Husky vehicles and a spares package called a Red-Pack. The vehicles are designed to be quickly repairable in the field after a

mine blast using items contained in the Red-Pack.

The MPCV is capable of interrogating and classifying suspected explosive hazards, including IEDs. It has an articulating arm with a digging/lifting attachment and camera to remotely interrogate a suspected explosive hazard and allow the crew to confirm, deny, and classify it. The MPCV also transports Soldiers, allowing them to dismount to mark and neutralize explosive hazards.

The M1271 MCV is a vehicle designed to clear large areas of anti-tank and anti-personnel mines by means of a rotating flail. The MCV is a manually-operated, self-powered vehicle with the capability to adjust flailing depth.

The IA is a mechanical counter-IED asset that provides Soldiers the capability of standoff detection and interrogation of suspected IEDs. The IA features a probing/digging tool to expose objects and a camera to identify targets. The IA system is utilized on the MMPV Type II platform.

The EHP capabilities will counter the full spectrum of conventional and asymmetric explosive hazards, including surface-laid, buried and concealed landmines, IEDs, explosively-formed penetrators, unexploded ordnance, battlefield munitions, and booby traps, as well as associated trigger mechanisms. The EHP systems include the MPCV-mounted Debris Blower, the Husky-mounted Wire Neutralization System and the MMPV Type II mounted Mine Roller.

Jellish said. "It also is reducing the SWaP on the vehicle because it's getting rid of all that dedicated hardware, so it frees up a lot of space in the vehicle and reduces cost."

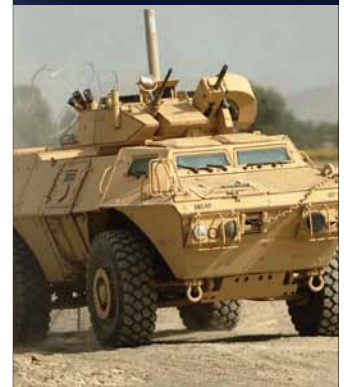
The Army Test and Evaluation Command is testing the MVDs in vehicles at Yuma Proving Ground, Arizona. NVESD engineers will review the results and address any concerns.

"It's where the truck should be going," Jellish said. "The capabilities are there, the processing power, the technology is there to do this. Now we're actually implementing that and getting it out into the field. That's the game-changing aspect of it, it's getting rid of all this multitude of displays that are in the vehicle and just bringing it down to one display at each seat, but that display can

control everything."

There is also the potential to integrate MVD into other Army vehicles in the future, Wilson said.

"We're just scratching the surface with this initial system and the initial capability we're putting out," Wilson said. "There's so much growth potential in this to actually potentially push video feeds to other trucks within the route clearance unit." ■



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STUDYING NEW MOLECULES

Chemical compounds known as metal-organic frameworks offer innovative chem-bio defense

BY ECBC PUBLIC AFFAIRS

Imagine a future in which a chemical attack on a Middle Eastern village in the dead of night has no effect on the people in its path. They are sleeping soundly in tents embedded with protective filtration material that prevents any harm. The village elders who come out to investigate have that same material in the headscarves they wear over their faces as they walk about with chemicals lingering in the air.

That day is coming closer. Two U.S. Army Edgewood Chemical Biological Center scientists, Greg Peterson and Jared DeCoste, are working with chemists at Northwestern University to make it a reality.

For the past eight years, Peterson and DeCoste have been steadily refining and improving a recently developed class of chemical compounds known as metal-organic frameworks, or MOFs. Chemists make them in a laboratory using organic struts and metallic nodes, much like an erector set, creating void spaces for chemical warfare agent or toxic industrial compound molecules to enter.

These modular building blocks are organic and inorganic molecular hybrids that take on the advantages of each. The inorganic characteristics give MOFs a very stable compartmentalized structure while the organic component gives them the dynamic quality of interacting with molecules that come into contact with them. Both the organic and inorganic components can be interchanged to create a variety of structures and properties designed to absorb or catalyze CWAs, TICs and other gases as desired. Thus, MOFs are truly nano-constructed designer materials.

As researchers continue to improve upon how precisely they assemble MOFs, the actions of these highly customized molecules will become dramatically more sophisticated. In theory, a sequence of MOF crystals could be structured so their pores serve as bays in which

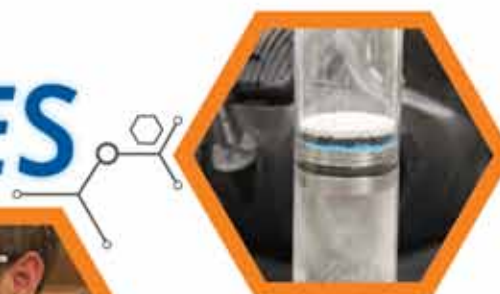
nano-manufactured proteins perform computing functions: counting, sorting and coding. This quickly leads to a future in which fibers, fabrics and even construction materials perform a wide range of intelligent functions.

For now, ECBC's efforts are concentrated in two key areas: protection and decontamination.

Peterson and DeCoste are working with a zirconium-based MOF, known as the UiO series, to take advantage of its broader filtration properties. They include removal of ammonia, cyanogen, chloride, blister agents and nerve agents. Their goal is to grow them on fibers that can transform a uniform, a tent or even a head scarf into personal protective equipment. This is a potential game-changer in the nation's efforts to establish stability in volatile Middle East countries that have suffered CWA attacks such as Syria and Iraq.

Peterson and DeCoste are also working on a new MOF, known as NU-1000, created by their research partners at Northwestern. NU-100 doesn't just trap the CWA molecules but breaks their bonds on contact. With the addition of water to flush the MOFs out, these MOFs do not get saturated and can keep on working. Because of that, this new MOF neutralizes agent eighty times faster than other MOFs created thus far.

As Peterson and DeCoste, and their research collaborators at Northwestern and several other research universities, gained more knowledge of MOFs through their protection



Above: Container of metal organic framework granules, which are used in protective filters, among other areas.



Left: Army chemist Greg Peterson exams an M-50 gas mask filter cartridge containing zirconium-based MOF material.



research, applications to decontamination starting becoming apparent. They saw that the MOFs they were working with actually decompose entire classes of chemical warfare agent or toxic industrial compounds on contact and in bulk, especially in the presence of moisture. But to fully exploit this characteristic, they have to find the MOF sweet spot.

"We are working with our university partners to design a MOF with both the best pore structure for agents to enter, and the most reaction sites where the decomposition occurs. This is hard because while big pores take in large molecules, they also place the reactive sites farther apart. We're working on getting the right balance," Peterson said.

Ultimately, Peterson and DeCoste hope to develop a decontamination powder that can be used to neutralize CWAs found in the field, and even a MOF aerosol that can be sprayed on a CWA-exposed surface such as an armored personnel carrier.

As Army scientists and their university colleagues create more sophisticated MOFs, their application may lead to a more innovative and effective chemical, biological defense. ■



FUTURE ARMY NANOSATELLITES

Nano-satellites may soon communicate with Soldiers from space BY DAVID VERGUN, ARMY NEWS SERVICE

Tiny Army satellites may someday provide Soldiers with voice, data and even visual communications in remote areas, which lack such communications.

Already some of that technology has been successfully tested, said Dr. Travis Taylor.

Taylor is the senior scientist for Space Division, U.S. Army Space and Missile Defense Command - Tech Center, or SMDC, at Redstone Arsenal, Alabama. He spoke during Lab Day at the Pentagon, May 14.

VOICE & DATA

In many remote areas where Soldiers operate today, Army radio over-the-horizon communication from the field to higher headquarters like the brigade is nonexistent, Taylor said.

To address this gap in coverage, Army scientists and researchers built the SMDC-ONE nanosatellite, he said, the ONE standing for Orbital Nanosatellite Effect. "It's basically a cellphone tower in space, except it's not for cellphones, it's for Army radios," Taylor said.

SMDC-ONE is currently a technology demonstration, he said, adding that one has been successfully tested. It's up in space right now communicating. Three more are scheduled to go up this year and an undetermined number will go up next year as well.

"Hopefully, we're at a point in the process where the technology is proven and they're wanted, perhaps three to five years" from

now, Taylor said.

"If we put five to 12 of these small satellites in orbit, it will cover most areas Soldiers are operating, providing them real-time, all the time" communications, he said. Once we've proven it can be done, it will be time to start to deploy a "real constellation" of them that the warfighters can use.

IMAGERY

What if a Soldier not only wants to communicate, but wants to see if there's a threat or something of interest over the next hill or the other side of a city? Taylor asked rhetorically.

The answer is an imaging satellite, which is several times larger than SMDC-ONE, but still considered nano, he said. This satellite, which is still unnamed, will be given a space test-flight in February, launched from the International Space Station.

The imaging satellite will produce a ground resolution of two to three meters, he said. That's high enough resolution to inform a Soldier if he's looking at a tank or a truck. Or, if there's smoke in an urban area, the Soldier will be able to tell which building it's coming from. "This is capability the Army doesn't have right now."

Once the technology is successfully demonstrated, the next step will be to establish the process for how it works and provide training to the Soldiers.

"The first step is proving we can collect [the data] and the next step is disseminating it," he

explained. For example, a squad leader might need to ask brigade for an image over the next hill. Someone at brigade would need to prioritize that request, because the satellite can only process one image at a time, usually in about a minute.

Then, the data from that image or even the image itself would need to be pushed out to the Soldier on the ground, he said. The details are still fuzzy about how all of that would work, so the focus for now is getting through the demonstration phase.

HOW IT'S PUT IN SPACE

The technology is already proven, Taylor said. The biggest challenge is getting the satellites hitched on a ride into space, where they'd be in low-Earth orbit. Most are launched now by piggybacking them as part of a larger payload of a spaceship.

One problem is, you can't put rocket motors on these to change their orbits, because it's considered too dangerous for the mothership and the other payloads, he said, meaning it could inadvertently explode. So, when the mothership drops off its payloads, the Army satellite might not be in an optimal position in space since the mothership can't zigzag around dropping off each payload in different places where their optimal orbits are located.

"So we developed a clever way around that," Taylor said, holding up a plastic container about the size and shape of a fancy pill bottle.

"This is an actual rocket motor, made from a plastic printer," he said. "Inside is liquid nitric oxide and a sparker -- just like a barbecue lighter inside -- so the nitric oxide combusts with the plastic" when the sparker is fired. "That's your rocket fuel. Then you have a very good rocket motor."

Once the rocket motor puts the satellite in correct orbit, the satellite still needs to orient its solar panel array so it's continuously tracking the sun and collecting energy, he said.

To do that, the satellite contains three wheels spinning in the x, y and z axis called momentum wheels, he explained. They act like gyros and can be programmed by speeding or slowing each one to adjust the orbit or orientation of the spacecraft. There are also magnetic torque rods in the satellite that interact with the magnetic field of the Earth to help align it.

Once in space, the satellites are not completely immune from damage, Taylor said. Besides space debris, there's solar flares and coronal mass ejections that could penetrate the satellite's shielding. "But we do everything we can to harden and ruggedize them."

These satellites are very inexpensive, he said, adding the biggest cost is the launch.

Taylor concluded: "It's exciting to work with spacecraft that can actually help warfighters in the field of the future. We've had many would-be users tell us that if they had this, they'd use it tomorrow, so I think the odds are good this will be something we see in the future." ■

MODULAR ACTIVE PROTECTION AND BETTER BUYING POWER 3.0

Army researchers invest in future with acquisition philosophy

BY WILLIAM NORTON, TARDEC

Henry Ford said, “If I had asked people what they wanted, they would have said faster horses.” This quote is often used to authenticate his successful development and innovation philosophy. Ford reinvented the basic concept of personal mobility by applying emerging technology, manufacturing and business techniques to allow his company to achieve his personal vision.

A similar philosophy has emerged in Army research and development.

The Modular Active Protection System, or MAPS, program is a Research, Development and Engineering Command-wide effort led by the Detroit Arsenal-based U.S. Army Tank Automotive Research, Development and Engineering Center.

The program’s evolution rivals the American consumers’ move to cars as its “faster horse.”

An active protection system, or APS, provides a military vehicle with automatic protection from armor penetrators and direct-fire threats such as rocket-propelled grenades and anti-tank guided missiles. An effective APS must include:

- sensing to detect potential threats
- high-speed processing to classify the threat and to derive a relevant fire control solution
- countermeasures to destroy the threat before the vehicle and its occupants are hit

To be successful, it must sense, classify and eliminate threats in a fraction of a second.

In the 1950s, the DOD demonstrated the realm of the possible when it began research and development on APS. Immature technology, component size and weight issues rendered the approach interesting but, ultimately, unfeasible.

Between 1980 and 2005, the Army re-engaged in active protection to defeat emerging threats. Army engineers demonstrated APS’

ability to defeat incoming threats, albeit on a limited basis. With today’s increased threats, focus has shifted from increasing performance to achieving capability transition to the Soldier via adequately described requirements for performance and a full, relevant operational environment.

This led the Army to the current MAPS program. MAPS is unique from the standpoint that it focuses on time to field integrated performance and time to upgrade. It reduces the likelihood of vendor lock. This modular and scalable approach will allow the Army to maximize value for current implementations while



Maj. Gen. John F. Wharton, U.S. Army Research, Development and Engineering Command (right) discusses advancements in armor and protection technology with Lt. Col. Michael Baker in front of TARDEC’s Concept for Advanced Military Explosion-mitigating Land Demonstrator during the 2015 DOD Lab Day at the Pentagon. (U.S. Army photos by Jerry Aliotta)



U.S. Marine Corps Commandant Gen. Joseph F. Dunford Jr. sits inside the Concept for Advanced Military Explosion-Mitigating Land Demonstrator, known as CAMEL, at the Department of Defense Lab Day at the Pentagon May 14, 2015.

engineering in the necessary integration hooks required to facilitate long-term competition and upgrades.

The Army has long recognized the value for establishing a sound capability and performance technology baseline, but it is now focused on the ability to adapt and perform in an uncertain future. The requirements-driven MAPS will help the Army focus future science and technology investments on specific technology gaps and affordability.

The Army's vision is to develop the government-owned framework to serve as the applicable interface standard facilitating competition at the subsystem level. This philosophy will help deliver reduced cost through an acquisition approach that streamlines investments.

Under Secretary of Defense for Acquisition, Technology and Logistics Frank Kendall presented an overview in 2014 that was consistent with Ford's manufacturing development philosophy.

"Continuous improvement is the best approach to improving the performance of the defense acquisition enterprise," he said.

Kendall's white paper focused on technology, affordability, open systems design and architecture. He stressed the goals for the acquisition and S&T communities to achieve affordable programs moving forward.

RDECOM and TARDEC are applying the concepts from Better Buying Power 3.0 to the MAPS program.

To achieve affordability goals, RDECOM's labs and research, development and engineering centers are partnering to develop a U.S. government-owned, open architecture and processor with defined interface standards for subsystems and components—sensors and countermeasures, among others—for the MAPS program.

This will foster innovation and lower costs for different configurations based on operational environments and platform constraints. The


open system design facilitates affordable technology refreshing and opportunities to employ performance-based logistics across the fleet.

A clearly defined, government-owned modular framework, central controller and subsystem requirements will allow DOD and industry to collaborate on current limitations and prioritize resources in ways previously not possible.

Ford implemented commonality, new technology investments and production and sustainment efficiencies in his early manufacturing processes. He would have likely embraced Better Buying Power 3.0 concepts and the simple design and efficient approach demonstrated by today's MAPS program. The Army isn't building a faster horse, just a more invincible one. ■


Editor's note: William Norton serves as the TARDEC Ground System Survivability chief engineer for Hit Avoidance.


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Regenerative Medicine

Regenerative medicine technology treats complex traumatic injuries offering hope for burn victims **BY CRYSTAL MAYNARD, USAMRMC PUBLIC AFFAIRS**

Conflicts in Iraq and Afghanistan brought a surge in burn and blast wound injuries from improvised explosive devices. Many who sustain such injuries endure years of rehabilitation and countless surgeries. Finding innovative strategies to heal these complex wounds more quickly, with fewer complications and less long-term impact from scarring, contractures and disability is a high priority for military medicine.

In 2008, the Department of Defense established the Armed Forces Institute of Regenerative Medicine, led by the Wake Forest Institute for Regenerative Medicine and Rutgers University.

“Regenerative medicine is a rapidly growing area of science that aims to unlock the body’s own ability to rebuild, restore or replace damaged tissue and organs,” said Kristi Pottol, director of the Tissue Injury and Regenerative Medicine Program Management Office. “Much of regenerative medicine research in the civilian sector is focused on finding ways to reduce

the burdens of chronic illness—diabetes, heart disease and others. The DOD wants to use these technologies to treat complex traumatic injuries.”

The Army is monitoring the progress of two new burn treatments under development with DOD funding:

- ReCell
- StrataGraft

Skin wounds are categorized by the amount of total body surface area involved and by the layers of skin tissue involved, both of which determine how the body responds, how the wounds heal and therefore, which treatment strategies are necessary. The larger and deeper the skin injury, the less likely it is the wound will heal without intervention. That’s where innovations like ReCell and StrataGraft come in, Pottol said.

The standard treatment for burn wounds is to harvest healthy skin from elsewhere on the patient’s body and to use it to cover

the burn wounds. This creates another wound on an already fragile body and is extremely painful for the patient.

ReCell, by Avita Medical, harnesses the skin’s own regenerative properties. In the operating room, surgeons take a sample of healthy skin about the size of a postage stamp place it into the ReCell device to create a suspension of individual skin cells.

Within 30 minutes, the resulting cell suspension can treat a skin wound that is 80 times larger than the skin sample taken. ReCell speeds the healing process, decreases the need to harvest skin from donor sites and improves the appearance of the burn scars.

StrataGraft is for more severe burns. Developed by Stratatech Corporation, StrataGraft is a living, meshable, suturable human skin substitute that reproduces many of the structural and biological properties of normal human skin. Patients with extensive skin injuries sometimes do not have enough remaining healthy skin to take

skin grafts from in order to cover all of the skin injuries with one procedure. In such cases, burns are covered with cadaver skin or synthetic dressings while waiting for donor sites to heal in order to re-harvest the site. But after about two weeks, the body rejects cadaveric or synthetic coverings. StrataGraft may eliminate the need for donor sites altogether. Surgeons would have a ready supply of tissue “off-the-shelf,” saving donor sites, reducing trips to the operating room and minimizing complications.

“The promise of both of these new technologies is that they could be the first substantial change in how burn and skin injuries are treated in the last half century,” said Dr. Wendy Dean, Tissue Injury and Regenerative Medicine Program Management Office medical advisor. “Sparing burn patients the pain of large donor sites, or offering surgeons a ready-made, permanent option for wound coverage could lead to a paradigm shift in skin injury treatment.” ■



Left: Soldiers from the 1st Armored Division, react to an explosion while participating in an urban combat exercise at a Fort Bliss, Texas, training facility May 11-12, 2011. (U.S. Army photo by Staff Sgt. Joseph Wilbanks)



DOD SHOWCASES

INNOVATION

BY DAN LAFONTAINE, RDECOM PUBLIC AFFAIRS

Military researchers demonstrated how their scientific and engineering efforts enable technological overmatch for Soldiers during the Department of Defense Lab Day at the Pentagon May 14.

Subject-matter experts from the U.S. Army Research, Development and Engineering Command's seven centers and labs displayed examples of their latest research to hundreds of uniformed and civilian defense employees in the Pentagon's Courtyard.

The CAMEL demonstrates research integrated into a vehicle platform from RDECOM's Tank Automotive Research, Development and Engineering Center.

Officials, including U.S. Marine Corps Commandant Gen. Joseph F. Dunford Jr., stepped inside the CAMEL for a closer look to inspect the vehicle's emerging technologies. Dunford will become Chairman of the Joint Chiefs of Staff when Army Gen. Martin E. Dempsey retires later this year.

The vehicle is the culmination of a three-year program, said Chantelle Korson, demonstrator lead for the CAMEL. Several design and engineering initiatives were developed for the project, and the components were combined with a focus on limiting injuries to Soldiers of all sizes.

Lessons learned from the CAMEL can be integrated into future military vehicle platforms, she said.

"There has been an increased blast threat in theater over the past five to 10 years," Korson said. "We have built mechanisms for transportability, high mobility and lethality, and then we've put Soldiers in those platforms. If I sit in some legacy platforms today, my head will hit the roof."

"We really need to design from the occupant out. Our population has also grown larger over the years. Historically we have done blast-testing with the middle-of-the-road Soldier. When you expand to smaller and larger people, your injury criteria changes and the problem becomes more difficult. The two main goals were accommodating that population and designing for increased blast protection."

Crowds lined up throughout the day to taste samples of new MRE components, including the long-awaited pizza. RDECOM's Natick Research, Development and Engineering Center leads MRE research.

Stephen Moody, director of the NSRDEC's Combat Feeding Directorate, said the Army field-tests MREs with 200 to 400 Soldiers and Marines each year.

Researchers provide new and existing components to measure preferences. NSRDEC then takes the highest-rated new components and swaps them for the lowest-rated existing components to ensure a fresh mix of rations.

"In 2017, we have the shelf-stable pizza coming up. It's one of the things we're highlighting today," Moody said. "It's one of the highest requested items in the MRE. It took a lot of science to get pizza that would last for three years at 80 degrees, but we were finally able to do that."

"With the pizza as well as shelf-stable pocket sandwiches that we're



Osie David (right), an RDECOM computer scientist, explains new communications and electronics technology to Mary Miller, deputy assistant secretary of the Army for Research and Technology, at the Department of Defense Lab Day at the Pentagon May 14, 2015. (U.S. Army photo by Conrad Johnson)

highlighting, we use hurdle technology. We control several factors within the food -- water activity, pH and oxygen within the package -- to create a barrier to microbial growth and to hinder the chemistry that degrades food."

Developing advanced armor protection for warfighters' body armor and helmets as well as combat vehicles is a major thrust area for the Army Research Laboratory, said Steve Taulbee, an engineer in ARL's Weapons and Materials Research Directorate.

"We're showing components and mechanisms in advanced materials that go into armors for protecting Soldiers against enemy weapon threats both on vehicles and while dismounted," Taulbee said. "It's a multi-disciplinary efforts that utilizes both the basic physical sciences as well as engineering disciplines."

"We have chemistry, physics and materials science for developing new mechanisms and materials. We have chemical engineering to advance the manufacturability of these armor materials. It's all about protecting the Soldier."

Enabling warfighters to maintain overmatch in low-light environments is a continuous goal of the Army and RDECOM, said Tom Bowman, director of the Ground Combat Systems Division at the command's Communications-Electronics Research, Development and Engineering Center.

CERDEC focuses on digital-sensor development to allow warfighters to view images on helmet displays and fuse digital imagery and symbology. Research also continues on transmitting images to remote locations.

"The Army is continuing to evolve night-vision goggles that will increase the dismounted Soldier's situational awareness and target-detection range and provide the capability to maneuver in all battlefield conditions," Bowman said. ■

TOP SCIENTISTS GATHER

Mad Scientist Conference at Georgetown University brings together innovative thinkers that could one day augment Soldier capability BY DAVID VERGUN, ARMY NEWS SERVICE

"Sentient data" that can feel and perceive things might one day protect Soldiers and their networks, a leading scientist said.

Thomas F. Greco, director of intelligence, G-2, U.S. Army Training and Doctrine Command, spoke during a media roundtable, April 30, about findings from the TRADOC-sponsored 2015 Mad Scientist Conference at Georgetown University, and attended by top scientists, innovators and thinkers throughout academia, industry and government.

The conference addressed how existing technologies will be used in new ways in 2025 and beyond and what new technologies would become game changers then.

People may have sensors implanted one day that would communicate and transmit data to other sensors in other people and systems.

Soldiers would "be able to conduct certain functions without having to make a conscious interaction into that loop," he said, meaning that the data being transmitted could provide situational awareness and mission command functions.

Data would be sentient in that it would know not to be transmitted to an adversary and if an adversary hacked into the data, the data would know not to go there, he said.

Data would also be sentient as it would be able to communicate to people and systems, where it is and what it is doing at any given time so that a network administrator would always know the status of the data.

Sentient data could also enhance Soldier potential for learning, much the same way a computer can teach a person how to become a grand master at chess, he said. It would be a man-machine partnership.

Gary E. Phillips, senior intelligence advisor, TRADOC G-2 Intelligence Support Activity, said packages of sentient data would come with their own operating systems and blur the distinction between operating systems and data.

This would also reduce system crashes and make life much simpler for Soldiers, Phillips said. By simpler, he said, sentient data would know just the right amount of information a Soldier needs for decision making. Currently, there is so much data out there that it can produce cognitive overload.

Greco said human sensors coupled with sentient data could result in "precision in knowing the Internet of things," thereby greatly reducing ambiguity.

The effect this would have on social interactions for an Army formation might impact order and discipline in ways that are unanticipated.

"Ambiguity is kind of a lubricant in personal relationships" but what happens when "you have total knowledge and accountability?" he asked.

There were many things discussed at the conference besides sentient data. Among them were ways to achieve cognitive dominance on the battlefield and the effects of genetic manipulation.

Col. Christopher G. Cross, Science and Technology Division chief, Army Capability Integration Center, TRADOC, said more studies need to focus on the brain and how it learns. According to Malcolm Gladwell's

book, "Outliers," it requires 10,000 hours of training or practice to achieve mastery.

The Army would like to cut that number down, Cross said, especially as weapons become more lethal and sophisticated. He pointed out that an Apache helicopter today has lethality equivalent to a battalion of World War II Soldiers.

In the future, a platoon may have twice the combat power it does today. Would that be too much responsibility for a second lieutenant? Would a captain be needed to command that platoon? The Army thinks not, he said, so a lot more work on ways and techniques to mature leaders quickly needs to be done. "The human component needs to be the centerpiece of all development."

Cross said what surprised him most at the conference was learning just how fast the biological sciences are advancing in terms of genetic manipulation and what impacts that might have on the Army.

The first forays into genetic manipulation will be altering DNA to eliminate diseases or provide enhanced capabilities in embryos. Then, that research could focus on changing the genetic structure of adults. "This caught me off guard," he said.

While this would likely not occur in the United States due to ethical and moral repulsion, state and non-state actors, who are our potential adversaries, would no doubt want to use it against us, he said, meaning designing super soldiers.

Greco said that this could give the enemy a temporary tactical advantage. However, by seizing the moral high ground, the United States could win strategically, as war has always been a human endeavor and others would recognize the repugnance of their actions. ■

"Sentient data," or information that can feel and perceive things, might one day protect Soldiers and their networks, said a leading scientist at U.S. Army Training and Doctrine Command's Mad Scientist Conference at Georgetown University in Washington, D.C., April 30, 2015. (Photo by Air Force Staff Sgt. DeNoris A. Mickle)



REVOLUTIONARY MORTAR SYSTEM

New system to boost speed, accuracy, enhance Soldier safety

BY ERIC KOWAL AND ED LOPEZ,
PICATINNY ARSENAL PUBLIC AFFAIRS

The ADIM, currently an 81mm mortar weapon system, uses "soft recoil" to reduce the firing loads transmitted to the platform by a factor of eight, well within the limits of light tactical vehicle capacity. This enables mounted firing and supports rapid mobile operations. (U.S. Army photo)

In certain battlefield conditions, such as the mountainous terrain and unimproved roads of Afghanistan, large-caliber indirect-fire weapon systems lack the mobility and maneuverability required to successfully execute an assault.

To solve this problem, engineers at the U.S. Army Armament Research, Development and Engineering Center at Picatinny Arsenal, New Jersey, are developing a revolutionary weapon system called the Automated Direct Indirect-fire Mortar, known as ADIM, which can be fired while mounted on a light tactical vehicle such as the Humvee or its potential replacement.

The ADIM, currently an 81mm mortar weapon system, uses soft recoil to reduce the firing loads transmitted to the platform by a factor of eight, well within the limits of light tactical vehicle capacity.

"This enables mounted firing and supports rapid mobile operations," said Dominick N. Carra, Senior Associate, Weapons Engineering Development, Weapons and Software Engineering

Center at Picatinny Arsenal.

The new mortar system is a projected supported by Army Science and Technology funding.

An associated benefit of the soft recoil system is the ability to fire the weapon (direct) at low-quadrant elevations as well as (indirect) at high-quadrant elevations to either compensate for terrain interferences or take advantage of the reduced time of flight associated with low-quadrant elevations firing solutions.

ADIM functions are automated so that operations normally conducted manually by the Soldier can instead be executed via electro-mechanical actuators controlled by the weapon Actuator Control System, which was also developed by Picatinny engineers and is a government-owned technology.

System operation is directed by the Automated Fire Control System -- Mortar, known as AFCS-M, which is an enhanced version of the fielded M95 Mortar Fire Control System.

The AFCS-M provides the human interface for controlling the loading/unloading, emplacing, aiming and firing of the ADIM.

A key capability associated with the AFCS-M is the incorporation of an inertial navigation unit and GPS receiver, which enables full-time emplacement of the ADIM and eliminates the long setup and reset times of several minutes associated with traditional surveying and aiming stake methods.

The combination enables rapid execution of mobile shoot and scoot operations to reduce Soldier exposure to enemy fire and susceptibility to counter-fire. It also provides the ability to operate via remote control as an unmanned weapon system operated by Soldiers in a protected location.

Although the system can be fired remotely, it is designed to require a Soldier to identify the target and make the decision to fire as prescribed in DoD Directive 3000.09 Autonomy in Weapon Systems, Carra said.

"Automation and fire control reduce the Soldier burden while increasing survivability," Carra added.

Army researchers demonstrated the system at the Army Expeditionary Warfighter

Experiment Spiral J event at Fort Benning, Georgia, in January 2015. The event is the Training and Doctrine Command's premier live fire, prototype experimentation campaign.

During two days of live fire exercises, Soldiers fired 174 rounds operating the ADIM via remote control. The ADIM also demonstrated its ability to rapidly engage multiple targets through several multiple aim-point missions.

Multiple target suppression missions (one round per target and then target sequence repeated) and automated search and traverse (or single gun sheaf) missions (firing multiple rounds into an area surrounding a specified target) were also executed.

"Give me ADIM and I'm ready to go back to Afghanistan," said a Fort Benning Soldier after observing the ADIM's performance.

Plans are under way for the ADIM to participate in Manned Un-Manned Teaming exercises as part of the Network Integration Evaluation 16.1 at Fort Bliss, Texas, in October 2015. ■





BETTER. SAFER BATTERIES

Army researchers develop batteries that don't corrode

BY C. TODD LOPEZ, ARMY NEWS SERVICE

New, lighter batteries are under development for Soldiers now, in-house, at the Army Research Laboratory at Adelphi, Maryland.

Chemists at the lab here do materials research on lithium ion batteries and other advanced battery chemistry in an effort to support the warfighter.

"We help to develop new battery materials that are lighter and last longer for the Soldier, so he doesn't have to carry so many batteries," said Cynthia

or phosphate cathode, which bears the "plus" sign. Between these two electrodes is a liquid electrolyte soaked separator that facilitates the transfer of lithium ions to transfer charge. One or more of these "cells" is used to construct a battery pack.

The team tinkers with the different materials that make up both the cathode and the anode. They also tinker with the chemistry of the electrolyte of the battery. Lundgren said

with the electrolyte is one of the key problems Lundgren and her team have proven successful at tackling.

"The electrodes are very corrosive, and they react with the electrolytes," said Arthur Von Cresce, a chemist at the lab. "So what ends up happening as you cycle the battery back and forth is that the electrolytes are degraded by the cathode because of the voltage of the cathode."

For the types of rechargeable batteries that Lundgren and her team are developing, that degradation means fewer charge/discharge cycles. Additionally, as the cells are charged and discharged, they retain less of their ability to hold a charge.

To prevent such degradation in a cell, the team created a solution called HFiPP—short for "tris (hexafluoroisopropyl) phosphate," which they use to enhance the electrolyte to make it more stable in high-voltage situations.

"It's a corrosion inhibitor," Lundgren said. "You just add it to the electrolyte that any manufacturer would put in. It's a little bit of pixie dust."

In the lab at Adelphi, the team is experimenting with a higher voltage iron-doped lithium cobalt phosphate cathode developed in the lab by fellow Army chemist, Jan Allen.

Von Cresce said the LiCoPO₄ cathode is particularly high voltage, at 4.9V.

"It seems to be more reactive towards the liquid electrolyte," he said. "This is a common problem among many varieties of experimental high voltage cathodes. It really seems to behave badly against unprotected liquid electrolyte."

But with the HFiPP solution added to the electrolyte for corrosion protection, the team was able to develop a battery that has both a higher voltage cathode, but at the same time is more stable. It can be charged and recharged many times, while maintaining its capacity and not corroding.

The lab expects to get commercial manufacturer samples of larger cells, called "pouch cells," that were built using the same chemistry they developed in their lab. They and other Army researchers will evaluate those cells for their performance and safety characteristics.

"We'll go through a number of evaluations," Lundgren said. "Do they perform as a pouch cell the same way they perform as a coin cell? One of the things you can't see in a coin cell is gassing. So if there is some reaction between the electrolyte and the electrode, and if you can get gassing you can make the pouch cell blow up."

Lundgren said she believes what they have developed at the Army Research Lab will make batteries lighter and last longer—something the Army wants in order to better equip Soldiers. ■

Kang Xu, an Army Research Laboratory scientist, is one of the inventors responsible for a 30-percent increase in energy density in lithium batteries. (U.S. Army photo by Conrad Johnson)



Lundgren, a chemist and Chief of the Electrochemistry Branch of the Power and Energy Division in the Sensors and Electron Devices Directorate.

To create a better battery, Lundgren and her team experiment with small "button cells," such as what one might find in a watch. A "cell" consists of two electrodes: an "anode," which is the side marked with a "minus" sign; and a metal oxide

that one way to make a battery lighter is to use electrodes that increase its cell voltage.

"If we could raise the voltage of a single cell—energy density is a direct function of the voltage—we could make the battery lighter," she said. "The problem is, as you go up in voltage, the electrode becomes much more energetic, and so it reacts with the electrolyte."

The reaction of electrodes

LASER TECHNOLOGY

Army, Air Force take bomb disposal to new level with lasers

BY CARLOTTA MANEICE, AMRDEC PUBLIC AFFAIRS

The U.S. Army and Air Force are working together to develop Mine Resistant Ambush Protected vehicles with laser technology.

Before, when the military wanted to disable a bomb, highly trained bomb disposal specialists wore body armor, protective suits or used robots to render an area safe.

With lasers, operators can negate the threat of improvised explosive devices, makeshift bombs, mines, and other unexploded explosive ordnance from a safe distance.

The U.S. Army Aviation and Missile Research Development and Engineering Center Prototype Integration Facility, U.S. Air Force Air Combat Command and the Redstone Test Center developed the technology.

The AMRDEC PIF will integrate the U.S. Air Force's laser, interrogator arm, console and other features into the Category I Cougar MRAP.

"Building the [Recovery of Airbase Denied by Ordinance, or RADBO] prototype was right in the wheelhouse of what the PIF is set up to do," said Steven Colvin, PIF Project Manager. "We were able to assemble a strong team of mechanical, electrical and design engineers to solve the problems, fabricators and integrators to build the prototype and technical writers to

document the installation, operation and maintenance of the system."

"We may see hundreds to thousands of small unexploded ordnance items on a runaway or airfield but the RADBO will allow us to reduce the time it takes to get an airfield operational," said Marshall "Doc" Dutton, Air Force Explosive Ordnance Disposal Modernization program manager of the Air Force Civil Engineer Center at Tyndall Air Force Base, Florida. "Currently if a runway gets hit it can take days to weeks to get cleared. With the RADBO, runways can be cleared and operational at a much quicker pace."

RADBO's laser can detonate bombs up to 300 meters and the Army's integrated interrogator arm and manipulator claw which can pull 50 pounds of debris up from cracks and underneath rubble. Infrared cameras, driver vehicle enhanced capabilities and two alternators were installed to provide over 1,100 amps of power.

"The biggest challenge for the PIF was the integration and mechanical maneuvering of adding a second alternator," Colvin said. "The stock alternator was only 570 amps and we needed more to power the laser. After modifying the nose of the Cougar MRAP and shifting the fan

and radiator forward we were able to install an additional alternator and double our power."

Another non-combat use of the RADBO is the ability for immediate range clearance allowing fighter pilots to use the range immediately after a live ordnance drop training exercise. Since ranges can be cleared immediately for repeated use, this capability has the potential to save lives on the battlefield.

"The PIF and the test center support have been superb," Dutton said. "We anticipate producing 14 more RADBO after the developmental testing phase to support the AFCENT command. We look forward to partnering with the PIF in the future."

Current testing on the RADBO includes munitions testing, hot and cold storage and electromagnetic interference. Developmental testing will conclude in July at RTC but additional tests will continue with Airmen at Tyndall Air Force Base in September 2015.

The PIF is a subordinate unit of the Engineering Directorate that plans, develops, manages, and conducts Aviation and Missile Life Cycle Management Command programs in the areas of total lifecycle systems engineering, product assurance, test and evaluation. ■



Left: The prototype vehicle contains the laser, interrogator arm and manipulator claw.

Below: The Recovery of Airbase Denied by Ordinance, or RADBO, prototype performs during the testing phase in February 2015 at Redstone Test Center, Redstone Arsenal, Alabama (U.S. Army photos)



Knowledge management emerging as key requirement for collaboration, innovation

ECBC Communications

The rapid pace of technology continues to be a catalyst for the way people live, work and play. Network connections have promoted mobile computing applications that have increased access to information and knowledge sharing, and as a result, empowered communication on an individual and organizational level. But is the network secure?

The U.S. Army Edgewood Chemical Biological Center R&D IT Enterprise uses the Defense Research Engineering Network. Its secure network technology facilitates how scientists and engineers are able to get the right information to the right people at the right time in order to fulfill their mission to advance chemical and biological defense.

The ECBC Corporate Information Office is the backbone for the Center's operations and has recently been established by Army Materiel Command as the Research and Development Center of Excellence for DREN supported SharePoint and Data Center consolidation. These Army directed consolidations create efficiencies meant to reduce costs and minimize the IT services footprint.

The ECBC R&D IT Enterprise provides for Army directed savings while serving as a mission enabler and business integrator to the R&D community. ECBC CIO has worked with AMC to consolidate their customer support to include the HQDA Installation Preparedness Program, OSD, Plans Integration and Analysis Office, PEO ACWA, RDECOM HQ, Army Research Laboratory, NSRDEC, AM-SAA and Chemical Materiel Activity.

"While managing the risk inherent to a research environment, we are able to respond to the unique requirements of the scientists and engineers that may need certain software to do their jobs," said Pam Kartachak, the G6 for the U.S. Army Research, Development and Engineering Command, and chief information officer for ECBC and CMA. "We feel we are making a difference in our ability to provide for the unique IT requirements needed by the R&D community."

"We use the Defense Research Engineering Network to provide information technology operational support to all three of these organizations and consider them a part of our enterprise," Kartachak said. "The security measures we've put in place allow us to manage the risk of an R&D-based network like the DREN, while still providing a flexible system that is suitable for the dynamic environment these organizations are in."

Read more: <http://www.army.mil/article/149488>

Natick's innovative test methods transition to Aberdeen Test Center

By Jane Benson, NSRDEC Public Affairs

NATICK, Mass. (June 9, 2015) -- Researchers, at the Natick Soldier Research, Development and Engineering Center, or NSRDEC, have devised new, more operationally-relevant ways to evaluate protective eyewear and soft-body armor. These new test methods and apparatus are transitioning to the Aberdeen Test Center, or ATC, and will be incorporated into standardized test operating procedures.

The quick transition to ATC has been enabled by the Science and Technology, or S&T, Objective, or STO, Force Protection Soldier and Small Unit program, formerly TeCd 1b, which focuses on aligning and transitioning science and technology projects to programs of record and various customers.

"STO Force Protection: Soldier and Small Unit comprises 77 projects that are delivering knowledge products, materiel, and test methods - all aimed at understanding and increasing Soldier performance and protection in an operationally relevant environment," said Jaclyn Fontecchio, STO lead, NSRDEC Warfighter Directorate. "New and relevant test methods are critical to the ability to accurately assess products or systems during their S&T development. As new products emerge through research and development, the use of standard test methods, as is or modified, are not always applicable particularly when dealing with revolutionary or novel products and materials. In many cases, new test methods are required to measure parameters of interest and require an upfront investment. Failure to do so can lead to non-conforming products, shortened product service life, and increased testing costs."

Natick's new test methods for protective eyewear and soft-armor protection were needed to evaluate evolving, state-of-the-art protection and new materials/designs, in situations where previous methods were incapable of testing the new materials/designs accurately.

The new test methods include a soft-armor flexibility test, a soft-armor durability test, an eyewear abrasion test, and an eyewear anti-fog test. The new NSRDEC-developed tests are consistent, accurate, reliable, repeatable, and most important, operationally relevant, to ensure that equipment better meets the needs of Soldiers.

Read more: <http://www.army.mil/article/150110>



A Soft Armor Flexibility Test Apparatus measures armor sample stiffness by plunging it through an 8-inch diameter hole with a 2-inch depth. The new test is operationally relevant and is based on Soldier input regarding comfort and range of motion.

McMaster outlines innovation, potential risks for Force 2025, beyond

By Amy Guckeen Tolson

HUNTSVILLE, Ala. (April 1, 2015) -- When it comes to the challenge of finding ways to innovate the Army to win in a complex world, Army leaders must be in tune with the risks and fallacies that could lead to undermining their own efforts.

Lt. Gen. H.R. McMaster, deputy commanding general, futures/director, Army Capabilities Integration Center, U.S. Army Training and Doctrine Command, addressed attendees during the 2015 AUSA Global Force Symposium on "Army Innovation Under Force 2025 and Beyond," March 31.

"We define innovation in the Army Operating Concept as really our ability to turn ideas into valued outcomes," McMaster said. "And then also to be able to do that in a way that we stay ahead of determined, and increasingly capable enemies."

The differential advantage the Army has over the enemy comes from "our ability to combine skilled Soldiers and well-trained cohesive teams with technology," McMaster said, which "presents our enemies with multiple dilemmas." But that doesn't mean that as the Army looks to the future that there are not challenges and risks to be aware of when it comes to innovation and winning future fights.

"The biggest risk that we have today is the development of concepts that are inconsistent with the enduring nature of war," McMaster

said. "What we see today is really an effort to simplify this complex problem of future war and to essentially make it a targeting exercise. This is not a new phenomenon, we call it the 'vampire fallacy.' You can't kill it, it comes back every 10 years. The idea is that the next technology we develop is going to make this next war fundamentally different from all those that have gone before it. We'll be able to solve that problem through exclusively stand-off capabilities, and precision targeting and precision strike in particular."

If the Army chooses to go that route, it could end up building vulnerabilities, leading to a narrowing of capabilities, and improper preparation for what the enemy might one day bring to the table. Relying on proxies to do the fighting for the Army is also a potential risk, McMaster said.

"The first real risk to innovation are theories and ideas about future wars that cut against war's political nature, war's human natures, war's uncertainty and war as a contest of wills," McMaster said. "We can mitigate that risk by communicating effectively."

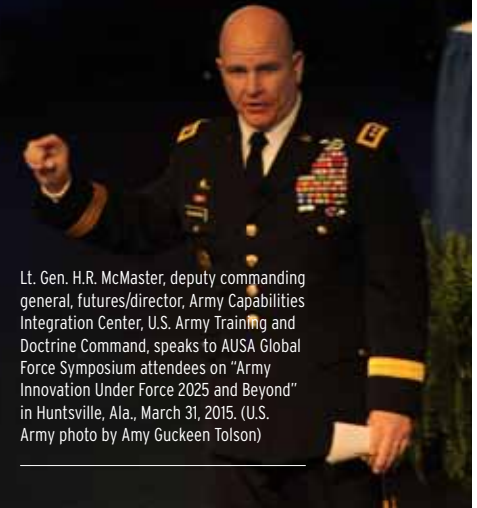
Another risk to innovation efforts is to under source those efforts.

"It's great for us to say how thoughtful we're going to be, how clever we're going to be, but a very, very clever force that doesn't have the tools it needs or the capacity it needs

to operate at a sufficient scale and for ample duration to accomplish the mission is going to be a risk," McMaster said.

The framework being used, as leaders think about future armed conflict and warfighting challenges, can be found in key factors: threats, missions, technology, history and lessons learned, McMaster said.

"Our efforts are aimed at two objectives, innovate overall, but to innovate with a higher quality and to innovate faster," McMaster said. "And to do that using the framework of the warfighting challenges, our learning events and our campaign of learning under Force 2025 maneuvers, while having an eye on implementation."



Lt. Gen. H.R. McMaster, deputy commanding general, futures/director, Army Capabilities Integration Center, U.S. Army Training and Doctrine Command, speaks to AUSA Global Force Symposium attendees on "Army Innovation Under Force 2025 and Beyond" in Huntsville, Ala., March 31, 2015. (U.S. Army photo by Amy Guckeen Tolson)

Army researchers look for permanent end to Ebola virus

ECBC Communications

ABERDEEN PROVING GROUND, Md. (May 19, 2015) -- The U.S. Army Edgewood Chemical Biological Center, or ECBC, and the U.S. Army Medical Research Institute of Infectious Diseases, or USAMRIID, are partnering to help expedite progress in the global fight against Ebola.

ECBC is working with USAMRIID on two critical studies - a vaccine study and a biomarker study - that will advance the global fight against Ebola.

Ebola is a rare and deadly disease caused by infection with the Ebola virus. The largest Ebola outbreak in history, which began in De-

ember 2013, is still ongoing. This disease has a high death rate - to date, there have been 22,000 cases and 9,000 deaths attributed to the most recent outbreak - with no known cure or effective vaccine. ECBC and USAMRIID are trying to change that.

USAMRIID, the Department of Defense's lead laboratory for medical biological defense research, called upon the ECBC-US Army Medical Research Institute of Chemical Defense Mass Spectrometry Core Facility to assist with two of its ongoing Ebola research programs - characterizing a potential vaccine and identifying biomarkers of infection.

For the vaccine work, ECBC is analyzing several different vaccine preparations provided by USAMRIID to quantify VP40 and glycoprotein concentrations expressed in virus-like particles generated from Ebola (strains Zaire and Sudan). The aim is to monitor quality control of the vaccine production process and to determine if a correlation can be made between protective immunity and the amount of Ebola-specific structural proteins, GP and VP40, that are present. This type of research is foundational in creating a long-term solution to a devastating disease.

Read more: <http://www.army.mil/article/148408>

Model Based Systems Engineering

The use of modeling enhances our analytical capabilities

BY THOMAS HADUCH, DIRECTOR OF SYSTEMS ENGINEERING, RDECOM

As our systems become more complex, integrated, interoperable and designed to operate in an increasing systems of systems environment, the use of modeling can enhance our ability to analyze and truly understand system performance behaviors and identify developmental risks.

Model Based Systems Engineering is an innovative approach that allows a systems engineer to organically create a methodology to assess and understand the challenges and risks and develop possible solutions associated with the development and implementation of systems.

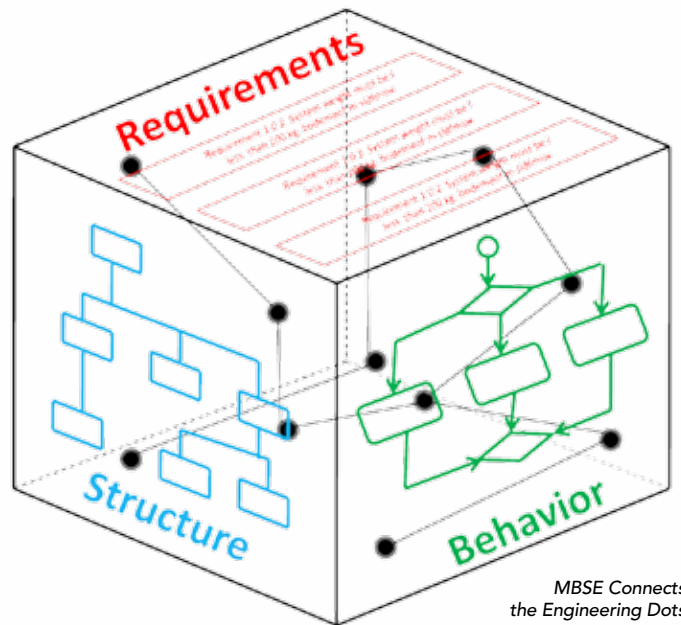
It is an emergent, increasingly accepted application of modeling as a more affordable and ease of analysis approach to systems engineering. Its innovation involves the systematic application of information and imagination of the processes to work smarter and not harder in our cost-constrained environment. It also enables more effective and efficient systems development processes by:

- Specifying the system as a single evolving computer model, not a series of disconnected, static documents
- Formalizing the practice of systems engineering through the use of analytical models
- Integrating with multiple modeling domains across the systems development lifecycle from systems of systems to system and sub-component
- Helping to manage complexity
- Incorporating predictive modeling and simulation analysis to conduct systems engineering trade analysis
- Encouraging and facilitating integrated architectures in projects for a better understanding of interfaces and a better understanding of system requirements, behaviors and structure

The importance of Model Based Systems Engineering quickly emerges when one compares and contrasts it to a traditional document-based approach to systems engineering. In a traditional approach, the process produces reams of paper documentation that appropriately outline requirements flow-down, functional analysis, design specifications, and verification and validation approaches in a stove-piped, expensive and time consuming format that is prone to errors and/or incorrect assumptions. Systems analysis becomes difficult when one wants to view system relationships between these domains. Add on top the complexity of a system interoperating with another in a network-centric format and/or in a systems of systems and it becomes exponentially difficult to do appropriate analysis whether it be functional determinations or sensitivity analysis of design feature iterations.

James Lackey, U.S. Army Aviation and Missile Research, Development and Engineering Center director, described Model Based Systems Engineering as the "ultimate cool way" to look at our systems in a refreshing approach that holistically captures the system in operation.

"It is a reinvigorated approach that I hope garners the excitement and attention of our young and future leader workforce," he said. "If and when



MBSE Connects the Engineering Dots

it makes sense from a timing and opportunity for insertion standpoint, use of Model Based Systems Engineering needs to be increasingly adopted so that RDECOM can provide the best, robust, systems-capture analysis and architecture of our enterprise and tactical products for our customers."

This is about growing our skill sets in this area and working to communicate the affordability and efficiency benefits of Model Based Systems Engineering to various program office leadership personnel. Using modeling techniques has caught more substantive defects and created more technical communication in a project than reviews of text-based documentation does.

Projects quickly realize the benefits of systems engineering with modeling when provided with a systems engineer experienced in modeling who could lead a facilitated discussion on a whiteboard. systems engineering with models emphasizes use of a common language and common data thus helping with communication, collaboration and consistency in work efforts across a project. Model Based Systems Engineering has a bright future and RDECOM is on the leading edge in its use for the Army. It is an ultimate innovation for our workforce as thinkers, designers and developers to ensure that modern, complex enterprise and tactical systems are created and produced in a more efficient and effective manner. Better Buying Power. ■

Editor's note: AMRDEC Director James Lackey contributed greatly to this column. Also contributing were Allan Lagasca, U.S. Army Armament Research, Development and Engineering Center, Rick Makowski, Program Executive Office for Intelligence, Electronic Warfare and Sensors, and Monte Porter from CSC.

ARMY

TECHNOLOGY GOES ONLINE!

As the contract for the print publication comes to an end, Army Technology Magazine will continue to publish Army research, development and engineering stories at the Army Technology Live blog (<http://armytechnology.armylive.dodlive.mil>) and the U.S. Army Research, Development and Engineering Command homepage (<http://www.army.mil/rdecom>).

RDECOM would like to thank Command Publishing for two years of support getting the word out about what Army scientists, engineers and researchers are doing to ensure decisive capabilities for unified land operations to empower the Army, the joint warfighter and our nation!





COLLABORATION INNOVATION LAB

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Ralph Tillinghast (right) is the founder and director of the Collaboration Innovation Lab at the U.S. Army Armament Research, Development and Engineering Center, Picatinny Arsenal, New Jersey. The laboratory serves as a peer-to-peer environment to spur on innovation by providing reference materials, prototyping equipment and state-of-the-art technology interaction.

Michael Wright (left) is an inventor and lab associate. He is also project officer for the Weaponized Universal Lightweight Fire-Control, which couples many small sensors together to create a robust, lightweight pointing device that will increase mortar fire.

ARDEC established the lab in 2009 to support the development of new fire control technologies. It now serves as an open environment to incubate new technologies for the warfighter. The lab also houses a large library of STEM-related materials for employees to check out and share with families and friends to promote outreach.

