ARMY TECHNOLOGY

NOVEMBER/DECEMBER 2014 | VOLUME 2, ISSUE 6

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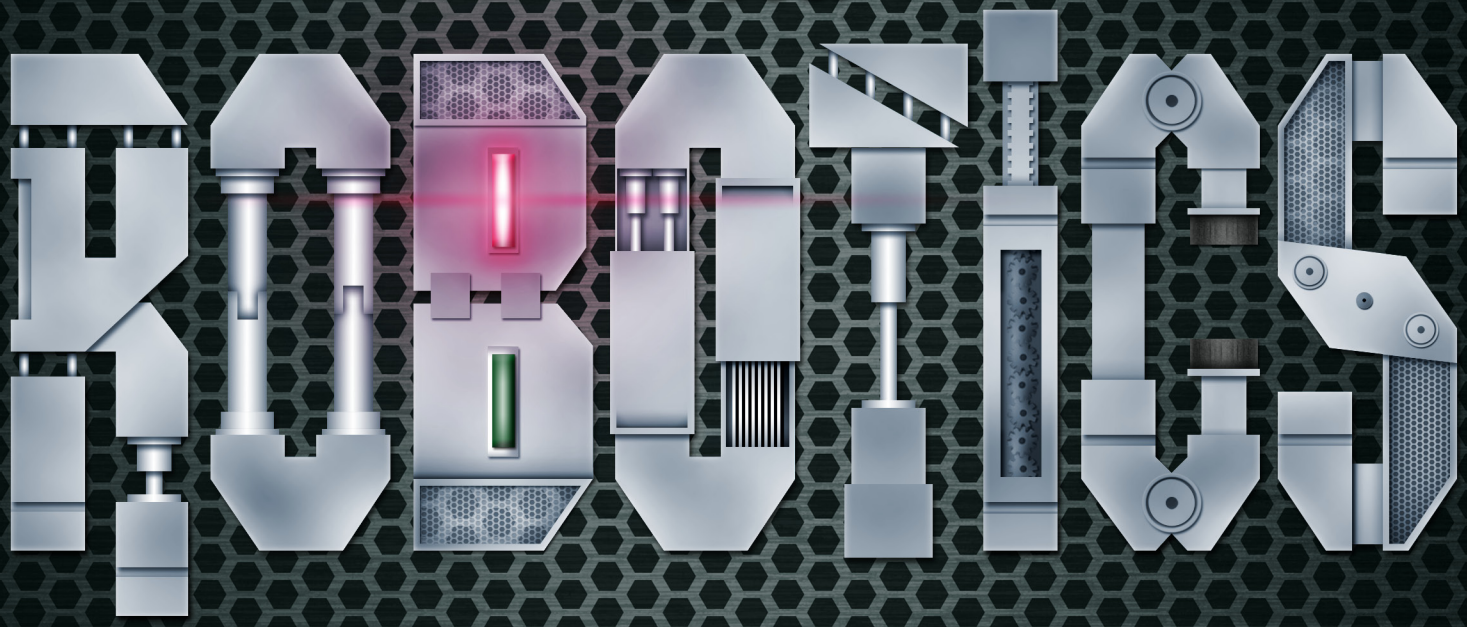

+ PLUS

INTERVIEW WITH

DR. PAUL D. ROGERS
TARDEC DIRECTOR

GENERAL DYNAMICS
Land Systems

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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

RDECOM welcomes a new leader Sept. 22, 2014 at Aberdeen Proving Ground, Maryland. View photos of the event online at https://flic.kr/s/aHsk43s727 (U.S. Army photo by Tom Faulkner)

Front and back cover designs by Joe Stephens

This issue explores Army research in robotics and autonomous systems. The U.S. Army Research, Development and Engineering Command partners with industry and academia all over the world to develop technology solutions that will give American warfighters the decisive edge on the battlefield. The command has six research, development and engineering centers and the U.S. Army Research Laboratory collaborating on projects designed to empower, unburden and protect the warfighter.

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RDECOM welcomes new leader

BY DAN LAFONTAINE, RDECOM PUBLIC AFFAIRS

The U.S. Army Research, Development and Engineering Command welcomed new leadership Sept. 22 as the Army returned a general officer to the organization's senior post.

Maj. Gen. John F. Wharton assumed command at Aberdeen Proving Ground, Maryland before a crowd of about 400 Soldiers, Army civilians and community members. He took the reins from Dale A. Ormond, who served as RDECOM director since Feb. 10, 2012.

"To the Soldiers, civilians, contractors and family members [of RDECOM], thank you for what you do in support of our Army and nation. Your professionalism and reputation for excellence is renowned all over the world," said Wharton, a 1981 graduate of the U.S. Military Academy who also served as AMC chief of staff.

RDECOM is the second major subordinate command of Army Materiel Command that Wharton has led. He previously commanded the Army Sustainment Command at Rock Island Arsenal, Illinois, from September 2012 to August 2014.

"It's a distinct honor and privilege to be here today and to take command of RDECOM. I am so proud that we provide our nation, both at home and abroad, the technology and capabilities to win anywhere at anytime. I'm fully committed to the people and mission of RDECOM to shape the Army of 2025 and beyond to ensure the decisive edge for our nation."

Gen. Dennis L. Via, AMC commanding general, said Wharton's experience and leadership skills will help RDECOM move forward as the Army and nation face challenges in a rapidly changing global security environment.

"Over the course of his stellar career, Maj. Gen. Wharton has been assigned to very challenging assignments at every level," Via said. "While at ASC, John led the command through an unprecedented transformation in both structure and function and set conditions for the command to successfully maintain its support to missions worldwide.

"John Wharton knows about leading complex, global organizations. The men and women of RDECOM are very fortunate to have Maj. Gen. Wharton take the reins of RDECOM today."

Ormond's next assignment will be as deputy assistant secretary of the Army (Plans and Resources), Office of the Assistant Secretary of Army (Manpower and Reserve Affairs).

"It's been my honor to serve you as your director, and I have no doubt that Maj. Gen. Wharton will lead you to new heights and accomplishments on behalf of the Soldier," Ormond said.

Gen. Dennis L. Via, (right) Army Materiel Command commanding general, presents the U.S. Army Research, Development and Engineering Command colors to Maj. Gen. John F. Wharton (left) Sept. 22, 2014, at Aberdeen Proving Ground, Maryland. (U.S. Army photo by Conrad Johnson)

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

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ARMY TECHNOLOGY

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The Future of Autonomous Vehicles

INTERVIEW WITH DR. PAUL D. ROGERS

Dr. Paul D. Rogers serves as director of the U.S. Army Tank Automotive Research, Development and Engineering Center at Detroit Arsenal, Michigan. He is responsible for providing executive management to deliver advanced technology solutions for all Department of Defense ground systems and combat support equipment. He holds a doctorate in mechanical engineering–engineering mechanics from Michigan Technological University, a master of science in strategic studies from the U.S. Army War College, a master of science in engineering-mechanical engineering from the University of Michigan at Dearborn and a bachelor of science in mechanical engineering from MTU.

Army Technology: Over the past 10 years, robotics, or autonomy-enabled systems, have gone from a novelty to an asset among Soldiers. What is the current view of autonomy-enabled systems in the field?

Rogers: One of the greatest threats to our servicemen and women in Iraq and Afghanistan has been the roadside bomb. For more than a decade of war, we've witnessed how unmanned systems have been effective at keeping our Soldiers at safe distances from this danger. As we plan for the future, we've determined that advanced autonomy-enabled technologies will play an even greater role in keeping our Soldiers safe. Not by replacing them, but by providing a continuum of capabilities that will augment and enable them, while filling some of the Army's most challenging capability gaps.

We've put a lot of work into developing a 30-year ground vehicle strategy, and user understanding and acceptance of autonomy-enabled technologies is vital for the Army to realize the strategy's full value. With today's fast-paced operational tempo, the Army experiences a lot of accidents due to driver inattentiveness, external distractions and fatigue. In the short term, the Autonomous Mobility Appliqué System [AMAS] technology, successfully demonstrated several times this year by TARDEC and Lockheed Martin, can solve these problems by providing our drivers with viable options, up to and including: conducting manned or optionally-manned missions; utilizing a suite of driver-assist features, such as adaptive cruise control, collision-mitigating braking, lane-keeping assist, electronic stability and rollover warnings; or operating in the fully autonomous mode.

The AMAS kit can be installed on many military ground vehicle platforms, providing driver assist safety enhancements that are easily understood by the drivers. Our goal is to ease the cognitive and/or physical burden placed on our Soldiers, and augment human performance to better enable mission accomplishment. Guided by the 30-Year Ground Vehicle Strategy, we will continue to integrate more scalable autonomy-enabled features into our ground vehicle systems in the future.

Army Technology: What is the TARDEC 30-Year Ground Vehicle Strategy and how will it impact autonomy-enabled systems and automation?

Rogers: The strategy is a living document that reflects where technology and ground vehicle capabilities are going over the next 30 years. The strategy helps us gauge what we are trying to achieve, what to invest in, who to partner with, and is comprised of three value streams:

- shape requirements for future programs of record
- develop new capabilities for current ground systems
- provide engineering support and services

The strategy provides an overarching framework to develop, integrate and sustain advanced manned and autonomy-enabled ground system capabilities for the Current and Future Force. The strategy is shaped through TARDEC's enduring engagement with the: Training and Doctrine Command, our higher headquarters—specifically, the U.S. Army Materiel Command and the Research, Development and Engineering Command; the Army's acquisition and programs of record management community; numerous other science and technology organizations across the Department of Defense; industry; and academia. The next generation of vehicle platforms will feature autonomous capabilities along with modular physical architecture, open electronic architecture for ease of upgrades, common and efficient powertrains, and flexible manufacturing for rapid and tailorable production.

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Army Technology: Innovation in this area is coming from all sides. How important is the Army's partnership with industry?

Rogers: Collaborating with partners from industry, academia, other government agencies and across DoD is vital to TARDEC's ability to integrate technologies and develop advanced capabilities that improve our warfighters' effectiveness and efficiency. TARDEC is the DoD ground systems integrator. We have highly skilled personnel and unique world-class facilities strategically located in the heart of the automotive industry. Our ties to the auto industry and the defense industrial base in southeast Michigan date back to World War II and endure to this day. The future of Army ground vehicle systems capabilities depends on continued strategic engagement with these partners.

Our vision is to be the first choice for technology and engineering expertise across the ground vehicle domain and the entry point for industry and academia to bring advanced automotive and autonomous technologies so we can then demonstrate their maturity and operational value to the Army. At the end of the day, everything we do is about getting the best technologies and ground vehicle capabilities into the warfighter's hands. This is a team effort and our ability to partner with industry and academia, as well as leverage their ideas, is absolutely critical to our success.

Dr. Paul D. Rogers serves as director of the U.S. Army Tank Automotive Research, Development and Engineering Center at Detroit Arsenal, Michigan. (U.S. Army photo)

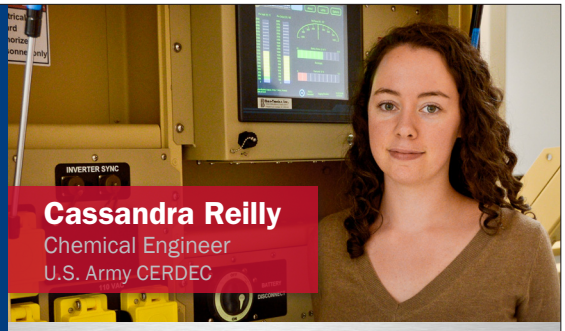
Army Technology: What do you want Army scientists and engineers to know as they continue to break new ground in autonomy-enabled technology research?

Rogers: The ever-changing strategic landscape requires flexible, adaptable and integrated technologies that transcend multiple platforms and operational environments. Autonomy-enabled systems deliver capabilities that unburden the Soldier and provide long-term value to the Army. To prevent, shape and win future conflicts in a changing world, Army S&T must deliver timely and technologically-advanced solutions that address our top priority capability gaps and ensure that our Soldiers have the very best equipment available. Autonomy-enabled systems will allow Soldiers to continue to dominate the battlefield, today and tomorrow.

Army Technology: How optimistic is your vision for the future of robotics and autonomous vehicles for the U.S. Army?

Rogers: We don't know exactly what the future holds, but with TARDEC's strategy, we are working closely with the user and acquisition communities to enable Army formations and unburden our Soldiers. We'll proceed with the knowledge that the nation needs the Army to respond anywhere on the globe with tailorable vehicles that can adjust to emerging threats and unpredictable environments. Autonomy-enabled vehicles will reduce accidents while augmenting warfighter capabilities, and increase battlefield mobility and lethality by creating greater stand-off distances from danger, making supply distribution safer and more efficient, and providing the flexibility to adapt to tomorrow's ever-changing and evolving threats. Nothing can replace the life of a Soldier. Autonomy-enabled systems will help make the Army more expeditionary, keep Soldiers safe and make them more efficient. ■

RDECOM SALUTES A STEM HERO



Cassandra Reilly
Chemical Engineer
U.S. Army CERDEC

Cassandra Reilly began working for the Army right out of college in May 2012. She has volunteered for local STEM outreach events and served as a member of a STEM panel at a local high school. Reilly also served as an online judge for the Army's eCYBERMISSION science competition for sixth- through ninth-graders and mentored sixth-grade finalists at the eCYBERMISSION National Judging & Educational Event.

"You never know what is going to be said or done to pique a child's interest in STEM," she said, "and you could be that difference."

For the complete interview go to:
http://www.army.mil/article/131986/
For a video of the interview, go to:
http://youtu.be/XXZgXPJDE8g

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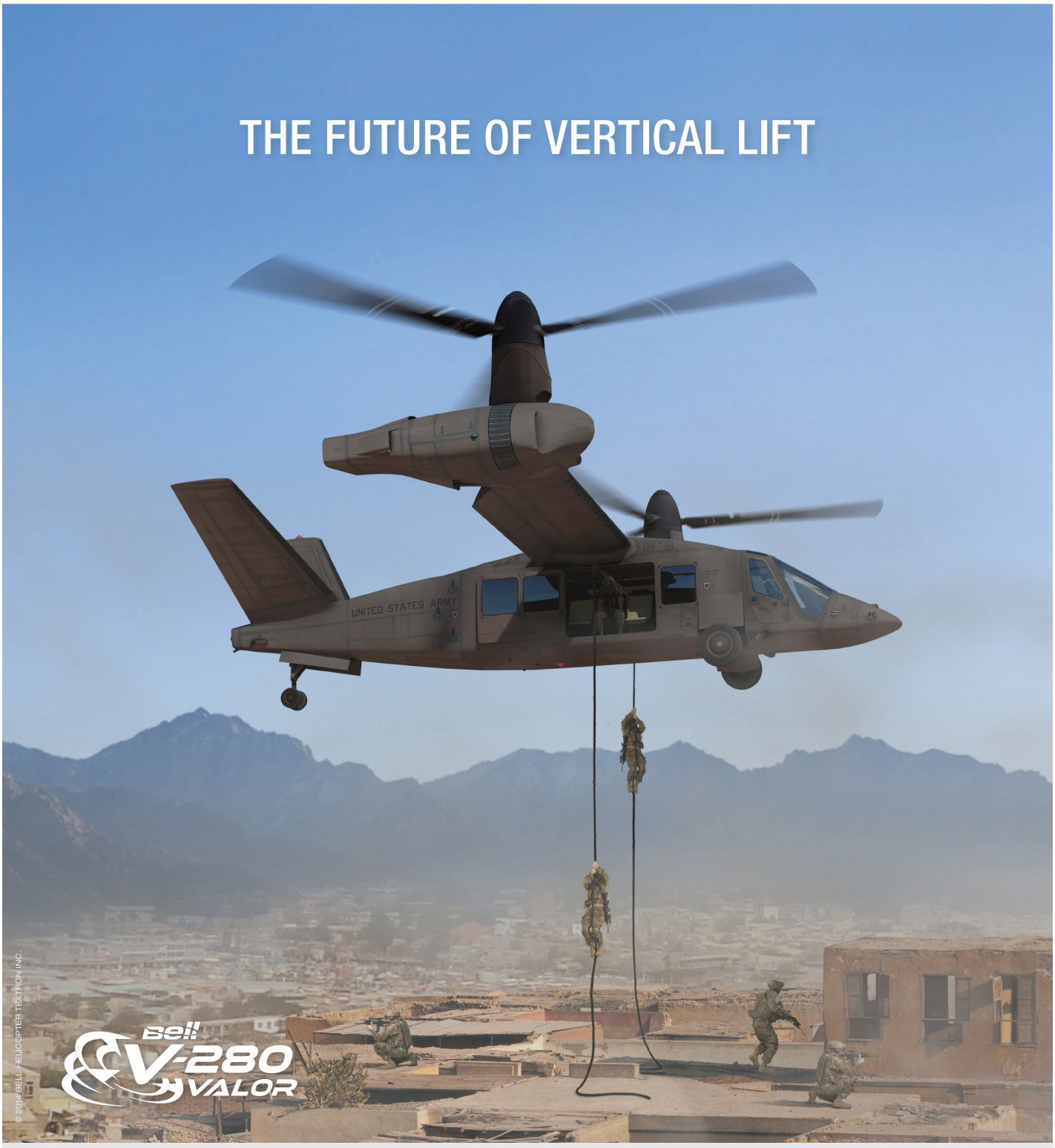

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ROBOTICS COMMUNITY OF PRACTICE

RDECOM is the Army's autonomous technology enabler

BY DR. GREGORY R. HUDAS, TARDEC GROUND VEHICLE ROBOTICS CHIEF ENGINEER

The U.S. Army Research, Development and Engineering Command is synergizing research centers and labs under its command to create a robotics community that will enhance the Army's ability to employ autonomy-enabled vehicle technologies to support the Soldier in every aspect of their operational life.

The U.S. Army Tank Automotive Research, Development and Engineering Center's Ground Vehicle Robotics division is spearheading that initiative for the RDECOM community to create a Robotics Community of Practice, known as the CoP. The new Robotics CoP will speak with one voice coming from RDECOM to provide a concise message to the Army and Department of Defense customers we support. It's all about removing redundancy across programs and collaborating a lot more closely as an enterprise.

The community charter, which is in the early development stages, will eventually help lay out the roles and responsibilities for each research, development and engineering center, whether that is by enabling autonomy, platforms, capabilities or usage. The CoP will also strive to achieve critical missions that regularly demonstrate evolutionary technology advancements, provide long-term data collection, promote open architecture across all stakeholder communities and strengthen those stakeholder partnerships. RDECOM needs the CoP to seek collaboration with key partners from academia, industry and the other service branches and federal laboratories to develop these autonomy-enabled vehicle technologies, and then demonstrate those systems, subsystems and capabilities to the user community—our Soldiers and Marines. Our collaborative partnerships are crucial for strengthening governance, standards and collective strategy moving forward.

Within the Robotics CoP, each RDEC will contribute to RDECOM's overall unified autonomy-enabled goals and objectives by focusing on their specified roles within the research and development community. Specifically, TARDEC's role will be as both a community leader and as the RDECOM RDEC responsible for maximizing research, development, transition and sustainment of technologies across ground systems and ground support systems as it applies to autonomy-enabled and optionally-manned robotics.

The Army Research Laboratory, the Army's corporate research laboratory, will apply its considerable expertise and leadership to assist the Army user in understanding the implications of autonomous technology on doctrine and in defining future needs of opportunities, especially in the area of robotic teaming of Soldiers and robots within the context of small unit tactical operations across a broad range of scenarios.

The Communications-Electronics Research, Development and Engineering Center supports technologies associated with radio/digital/electronic/cyber areas that enhance command and control, communications, computational hardware, electronics and sensors.

TARDEC Chief Engineer and Senior Technology Expert for Robotics Dr. Greg Hudas (standing) and TARDEC research scientist Jeremy Gray test circuit boards from a Packbot robot being completely refurbished at the center's Small Robots Laboratory. (U.S. Army photo by Amanda Dunford)

The Aviation and Missile Research, Development and Engineering Center provides research, development and engineering technology and services for aviation and missile platforms. Their expertise is particularly crucial for the Robotics CoP in developing unmanned air/unmanned ground platform teaming. In August 2014, AMRDEC, TRADEC and Lockheed Martin successfully conducted a fully autonomous resupply, reconnaissance, surveillance and target-acquisition demonstration using the Squad Mission Support System unmanned ground vehicle, K-MAX unmanned helicopter and Gyrocam optical sensor at Fort Benning, Georgia.

The Armament Research, Development and Engineering Center, an internationally acknowledged hub for the advancement of armament technologies and engineering innovation, will provide operational expertise on lethal and non-lethal payload technologies in accordance with the Robotic CoP's mission needs and requirements moving forward.

The Edgewood Chemical Biological Center provides research and development technologies associated with chemical and biological detection, protection and decontamination. ECBC's science and technology expertise has protected the United States from the threat of chemical weapons since 1917. Since that time, the Center has expanded its mission to include biological defense and emerges today as the nation's premier authority on chemical and biological defense

The Robotic CoP's final member, the Natick Soldier Research, Development and Engineering Center, maximizes the Soldier's survivability, sustainability, mobility, combat effectiveness and quality of life by treating the Soldier as a system. NSRDEC will deliver world-class research, development, systems engineering and services, bringing a unique

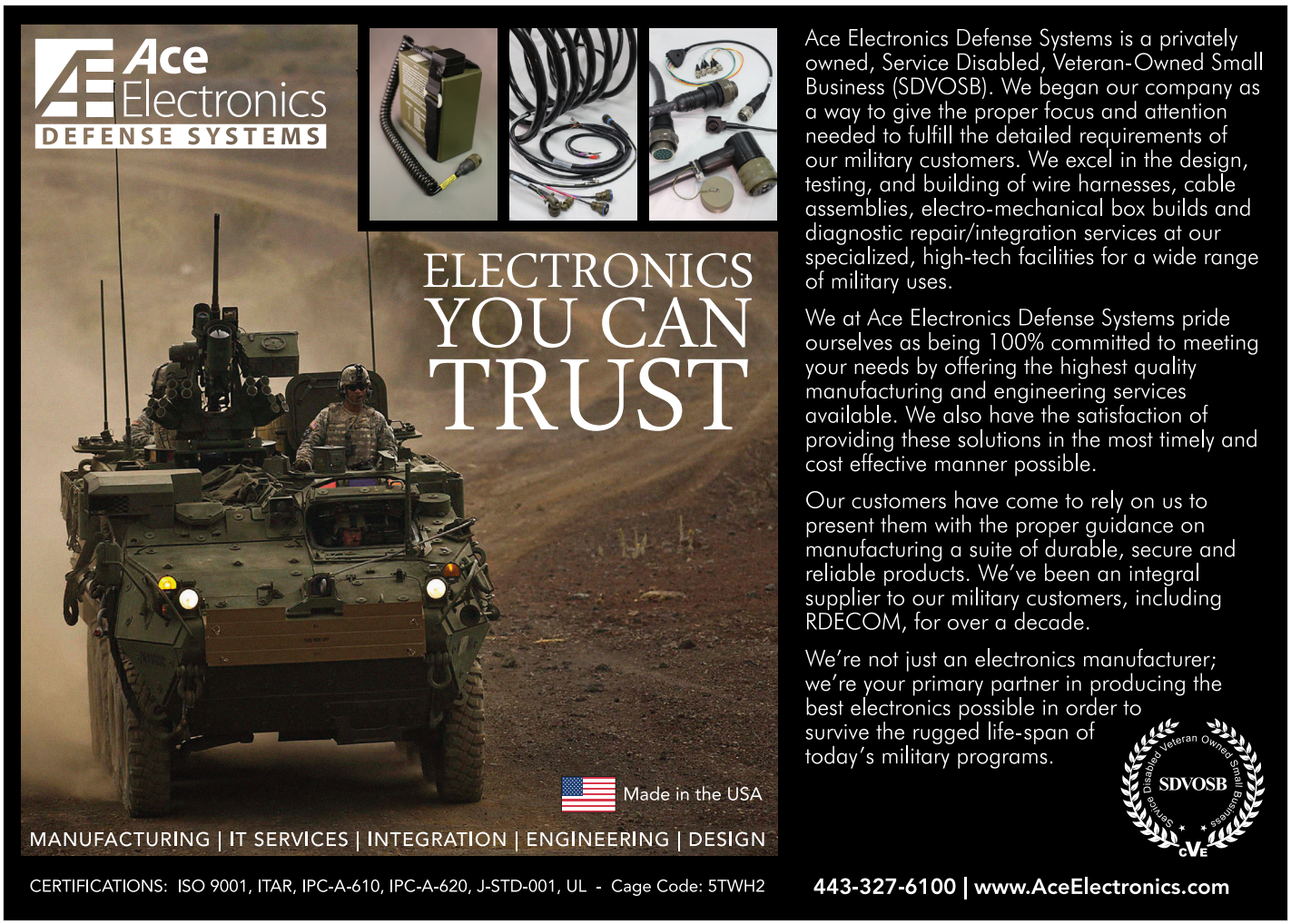
human-centric focus to the community as it explores the intricacies of Soldier-Robot peer-to-peer operations and capabilities.

The Robotics CoP will be the Army's science and technology voice for autonomy-enabled systems and will bring together stakeholders, including the combat developers, acquisition community and test and evaluation community. Bringing the T&E community on board early is important because test procedures for robotics and autonomy are still very immature. As we make machines more responsible when dealing with humans in peer-to-peer relationships, the T&E expertise is critically important. They need to be involved with the S&T world very early on in the development process, because they will grant the safety releases and safety certifications for autonomy-enabled platform operations in the future.

TARDEC's role as the Robotics CoP community leader will allow the overall organization to provide systems-level metrics back to Office of the Secretary of Defense R&D organizations. Simply put, when we start feeding system-level metrics back to our partners, we are helping to translate what they want into S&T terms that they can then push to the basic research areas. This will hopefully eliminate the dreaded 'valley of death' so when we develop something, it won't end up sitting on a shelf some place.

In the end, a shared community of interest will provide RDECOM's most important customer, the Soldier, with unprecedented world-class capabilities unmatched on the battlefield. We want autonomy-enabled and robotic systems to be a member of the unit. From a teaming aspect, it is a peer-to-peer relationship within the Soldier-as-a-system construct. Ultimately, warfighters will perform missions with robotic assets and they will treat those assets as peer equivalents, not as electronic slaves, dogs or mules. We've got a long way to go from both an R&D and S&T perspective to reach this dynamic end state, but RDECOM has assembled a community of expertise never before seen in the area of autonomous ground and air platform capabilities. Collectively, the Robotics CoP will embrace this opportunity to create collaborative partnerships to accelerate the delivery of new capabilities to the warfighter, while avoiding unnecessary duplication of effort and development costs along the way. ■

Editor's Note: Dr. Greg Hudas is the Chief Engineer and Senior Technology Expert for Robotics at the UU.S. Army Tank Automotive Research, Development and Engineering Center at Detroit Arsenal, Michigan. He provides technical expertise and strategic support in all areas of robotics to senior Department of Defense and Army leadership. He holds bachelor of science, master of science and doctorate degrees in electrical and computer engineering with research emphasis in intelligent systems and control of mobile robotic systems. He has authored and co-authored over 40 technical journal articles and major conference papers, and is an adjunct professor at the University of Alabama-Birmingham. Matt December, TARDEC Public Affairs, contributed to this article.



Seven unmanned military trucks cruise by at speeds up to 40 mph during a test of the Autonomous Mobility Appliqué System Joint Capability Technology Demonstrator known as AMAS. (U.S. Army photo)

AUTONOMOUS SYSTEM DEVELOPMENT

The U.S. Army prepares for the future

BY DAVID MCNALLY, RDECOM PUBLIC AFFAIRS

The U.S. Army has invested in robotics technology for many years, and the focus is ever increasing toward autonomous system development.

Matt Donohue is the Science & Technology ground maneuver technology portfolio director for the Office of the Assistant Secretary of the Army for Acquisition, Logistics and Technology.

"My vision is for Army vehicles to have scalable autonomous capabilities," Donohue said. "For Army tactical vehicles, this means scalable autonomy from leader-follower to fully autonomous capable, including the ability to be loaded and unloaded by autonomous material handling equipment."

Matt Donohue

In Donohue's vision of the future, combat vehicles will have similar scalable autonomy for movement and maneuver, but restricted engagement capabilities.

"Armed robots may be technically feasible, but policy, legal and safety concerns may limit the Army's ability to deploy armed robots in tactical roles," he said.

Although there is still a lot to be done in development, testing and engineering, Donohue is optimistic about the current pace of innovation.

"For certain mission sets, most of the technologies we need for autonomous ground systems are mature and, in some cases, are being offered commercially by the automotive industry," he said. "These include the sensors and cameras used to enable active safety in vehicles, such as self-parking cars, blind spot detection, lane departure warning and lane keeping, backup cameras, adaptive cruise control and active braking."

As these individual technologies mature and gain acceptance, autonomy will evolve layer-by-layer, he said.

"The ability to logically link all of these technologies to enable autonomy for ground applications is one future for the Army," Donohue said. "The near-term application is most likely related to using these technologies for active safety and to enable a convoy leader-follower capability."

Active safety implementations will have a dramatic effect on saving lives and money.

"A significant amount of dollars could be saved annually if we get this right," he said. "Active safety is step one, and it will have a significant impact on drivers. It will save lives."

Donohue noted that retrofitting current Army truck designs with autonomous systems may be like a "MacGyver-like" solution, but it shows the potential for future vehicle designs.

The Army, in its partnership with industry, successfully tested the Autonomous Mobility Appliqué System Joint Capability Technology Demonstrator known as AMAS.

"The success of the JCTD has the Army thinking about the possibilities of this capability for the future," Donohue said. "While we've all seen basic robots in sci-fi movies and car commercials for a long time, the interesting ones were autonomous ones able to sense their environment and use that information to take actions."

From the Google self-driving car to autonomous vehicles being licensed and allowed on the road in some states, Donohue said it is apparent that industry has become a key player in the world of autonomy.

"Being able to work with and leverage industry investment in autonomy will ensure the technology moves forward for the Army as well," Donohue said. "Partnering with industry will ensure that the autonomous systems will be producible."

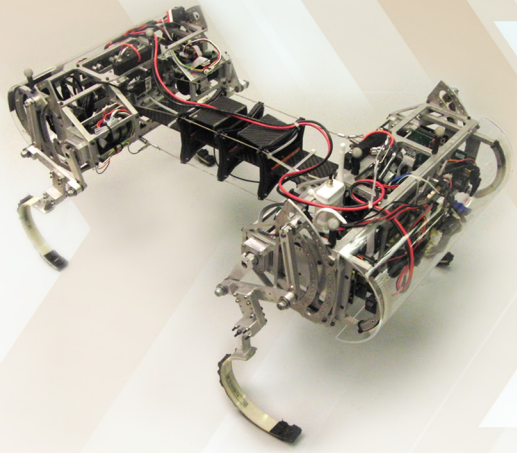
Donohue pointed to an annual science and technology budget of about $23 million for investment in the development of robotics and autonomy for ground applications.

"Robotics and autonomous systems have shown promise for many years," he said. "With shrinking budgets and a potentially shrinking force structure, I think now is the time for autonomous ground systems, if done correctly, to make it into the force." ■

Far Future

Robotics Collaborative Technology Alliance

BY DAVID MCNALLY, RDECOM PUBLIC AFFAIRS



The U.S. Army envisions a future where robots are integral members of the team performing autonomous actions and maintaining current capabilities.

Five years ago, the Army Research Laboratory set out to pursue this vision by forming the Robotics Collaborative Technology Alliance. It sought partners in industry and academia to explore technologies required for the deployment of future intelligent military unmanned ground vehicle systems.

"The future for unmanned systems lies in the development of highly capable systems, which have a set of intelligence-based capabilities sufficient to enable the teaming of autonomous systems with Soldiers," said Dr. Jonathan A. Bornstein, chief, Autonomous Systems Division for ARL and the collaborative alliance manager. "To act as teammates, robotic systems will need to reason about their missions, move through the world in a tactically correct way, observe salient events in the world around them, communicate efficiently with Soldiers and other autonomous systems and effectively perform a variety of mission tasks."

The paradigm shift is taking robots from being a tool to being a teammate.

"We're not as far advanced as we would like to be. You have to have a stretch goal. If you don't, you won't strive to get there," he said.

The Robotics Collaborative Technology Alliance, or RCTA, brought together ARL researchers and eight industry and academic partners:

- Boston Dynamics
- Carnegie Mellon University
- Florida State University
- General Dynamics Robotic Systems
- Jet Propulsion Laboratory
- QinetiQ North America
- University of Central Florida
- University of Pennsylvania

The Army has extended the alliance until April 2020; however, Boston Dynamics, which was recently acquired by Google, will not continue as a member.

"Clearly, collaboration is at the heart of the RCTA program," Bornstein said. "Great progress in fundamental research can be achieved by bringing together researchers who have not previously worked together – as well as by fostering further collaboration among those who have. We need to engage academia and industry so we can get the best possible product. We leverage people to work on problems of importance to us. If we don't get out there and interact with people, they will drive the train in perhaps a different direction, and we won't benefit from it."

So far, the RCTA has provided many benefits to Army research. Scientists are advancing adaptive tactical reasoning; focused situational awareness; efficient proactive interaction with humans; safe, secure and adaptive movement; and enhanced robotic interaction with the physical world. Researchers anthropomorphically describe these capabilities as think, look, talk, move and work.

"Currently, there are major technical barriers which lie in the way of this vision," Bornstein said. "At the heart of the problem is the need for a world model, which can be instantiated on robots and which represents the range of entities, spatiotemporal scales, and abstractions that must be reasoned about. There is also a shortcoming in a robot's ability to sense the environment and understand it at a semantic level; this ability is needed in order to populate the world model with new and relevant information. Robots have only a rudimentary capability to plan behavior, and their planning is focused almost entirely on navigation and is brittle even in that limited domain."

Brittleness is one problem that Army researcher Chad Kessens is tackling, with help from multiple RCTA collaborators.

"I learned that one major problem Soldiers face in the field is that the robot sometimes tips over," Kessens said. "I set out to develop a set of algorithms that would enable any robot to self-right, and several RCTA members also became interested."

Kessens, who is working toward his doctorate, said the Army needs solutions to maintain battlefield superiority and to provide maximum protection to Soldiers.

"The CTA provides a foundation to facilitate top researchers from disparate fields to coalesce around these problems and find solutions," he said. "It's fun to be a part of that."

Fellow ARL roboticist Jason Pusey is working on a unique autonomous quadruped robot called Canid, whose torso consists of a parallel actuated flexible spine.

"This research is being studied collaboratively between ARL and University of Pennsylvania and we are beginning to work with University of California Santa Barbara on more sophisticated controller methodologies," Pusey said.

In the past, quadrupedal robotics all possessed rigid spines. Recently Boston Dynamics and MIT unveiled a quadrupedal robot with a non-rigid spine.

"The difference between my research and Boston Dynamics and MIT is that I am investigating not only including an actuation mechanism within the spine, but also a flexible element to capture the energy imparted into the robot on each gait cycle and recycle this energy back into the next gait."

Pusey said the robotics alliance is an "exceptional program."

"This program was created to bring as many of the best minds together, and collaboratively strive toward making future robotics a reality," he said.

Bornstein looks to the future with hope.

"A lot of things that you might think are impossible, if you go far enough down the road, it will become possible. I'm grounding myself in what I think is in the realm of the doable within the next 50 years," Bornstein said. "It's basic and applied research. ARL is really focused not on the next system, but the system after the next system. This is really laying the foundation." ■

The Ripsaw Unmanned Ground Vehicle engages a stationary target at a distance of 700 meters using the M2 50 Caliber Machine Gun. (U.S. Army photo)

REMOTE LETHALITY

Army researchers address a host of challenges

BY ED LOPEZ, PICATINNY ARSENAL PUBLIC AFFAIRS

In popular culture, the idea of robots that perform human-like functions has a special hold on the imagination, based on real-life examples like space exploration, unmanned aerial drones and stoked by futuristic scenarios in movies like the "Terminator" series.

The military has used and experimented with robots that perform functions such as scouting and surveillance, carrying supplies and detecting and disposing of improvised homemade bombs.

However, when it comes to integrating lethality, such as a weapon capable of firing 10 rounds per second onto an unmanned ground vehicle, issues arise such as safety, effectiveness and reliability, as well as military doctrine on how much human involvement is required.

Remote Weapons Branch technical lead Robert Testa from the Armament Research, Development and Engineering Center at Picatinny Arsenal, New Jersey, recognizes the growing evolution in autonomous technologies and is focused on improving existing remote weapon technologies for manned and unmanned platforms, as well as fixed-site applications.

Testa said the term "supervised autonomy" strikes a contemporary balance between schools of thought that range between total human control (tele-operation) and researchers who are developing the technologies to enable robots to think for themselves.

Tele-operated means a human makes all the decisions regarding the activities of a remote platform, which is linked to the operator through a radio frequency or a physical link such as copper cable or fiber.

"I believe that UGV and robotic platform developers apply the term 'supervised autonomy' because not only do robust fully autonomous ground platforms still require substantial development, but it is essential that any UGV have the capability to react to command and control from a human operator under certain circumstances.

"This is similar to the addition of limited autonomy to RWS, but our primary focus has to be the robust, real time, tele-operation capability to ensure safe and effective weapon operation, regardless of the platform or application."

Supervised autonomy also reflects the current state of technology.

"There are some areas where we and our partners are developing the capability to add degrees of supervised autonomy for weapon systems, but we recognize that you will always require real-time manned supervision of what the RWS is aiming at, what targets are engaged, and when that engagement takes place, i.e, trigger pull," Testa said.

Army research into remote lethality complies with Department of Defense Directive 3000.09 'Autonomy in Weapon Systems,' published in November 2012. The protocols reflect the current doctrine addressing all classes of remote and unmanned weapon operation designed to allow commanders and operators to exercise appropriate levels of human judgment over the use of force.

"We can easily enable current generation remote weapon systems to aim and engage targets autonomously," Testa said. "Yet current doctrine and the realization that current sensor and processor technologies would provide little or no assurance to what was engaged, keeps the real time tele-operation mode of weapons use at the center of what we develop and demonstrate today.

"Today's current remote weapons systems are primarily developed and deployed as tele-op weapon systems, yet they inherently lend themselves as the starting point for the future of UGV lethality," Testa continued. "The RWB is working to make remote weapons more remote."

"The two primary facets of the RWB research are to develop advanced functional capabilities for the weapon system and the development of the system architecture and communications between the operator and the weapon, enabling development of extension kits that can support various transmission media such as radio frequency or a physical link such as optical fiber."

Researchers are aware that the term remote weapon may evoke an image of something operating many miles away with a high degree of autonomy; however, remote could also mean a weapons system on top of a vehicle with the operator inside under the protection of armor.

At ARDEC, a remote weapon system is closely associated with something like the fielded Common Remotely Operated Weapon Station, also known as CROWS.

CROWS is a stabilized mount that contains a sensor suite and fire-control software. It allows on-the-move target acquisition and first-burst target engagement. Capable of target engagement under day and night conditions, the CROWS sensor suite includes a daytime video camera, thermal camera and laser rangefinder.

CROWS supports the MK19 Grenade Machine Gun, M2 .50 Caliber Machine Gun, M240B Machine Gun and M249 Squad Automatic Weapon -- weapons originally designed for manned operation. The Army has integrated the system onto more than 20 platforms, from the HMMWV to the M1 Abrams tank.

Yet, current-generation remote-weapons systems as CROWS cannot support other functions essential to making remote weapons more remote.

The ARDEC-developed Advanced Remote Armament System, or ARAS, has additional capabilities, such as an externally powered, purpose-built weapon to improve reliability and accuracy, the ability to load and clear the weapon remotely and an increased stowed ammunition load without decreasing aim or stabilization. It can also reload the weapon or change ammunition type without manned intervention at the weapon in approximately six seconds.

Also critical for future asymmetric engagements is the ability to change from lethal to non-lethal ammunition that ARAS provides. ARDEC has developed both 7.62mm and .50 caliber ARAS prototypes. The ARAS patents are owned by the U.S. Army, which enable cost-effective acquisition once future requirements are generated.

Although ARDEC does not develop vehicles or platforms for its weapons, it has used a tele-operated MS3 Ripsaw as a "surrogate platform" for the development of UGV lethality technologies, including wireless extension kits for CROWS, ARAS and other remote weapons systems.

These programs have culminated with the first unmanned ground vehicle Scout Gunnery Table VI experiment in November 2013 at Fort Dix, New Jersey. ARDEC also works with other government and industry partners to weaponize UGV platforms.

While some UGV functions may include such things as carrying equipment, surveillance or removing homemade bombs, their functions are not lethal in nature. But incorporating powerful weapons onto a UGV presents a number of technical challenges, including minimizing or eliminating latency.

Latency means delay or the time elapsed between using controls to initiate an action and when it actually happens. This is particularly critical when you have high-rate-of-fire weapons, Testa said.

Latency also applies to video, or the time elapsed between the images captured by a RWS mounted camera and when they actually appear on the screen of the operator.

"Latencies are bad, and they are technically challenging, especially video latency," Testa said. "Our goal is to minimize video latencies as much as possible and we are targeting a maximum of 250 milliseconds, or quarter of a second."

Testa said humans start to notice latency at around 250 milliseconds. "You start to sense, 'I moved the joystick, but I didn't see the reticle move right away.' "

Said Testa: "You want your video to be real-time as much as your controls are real-time. I pull the trigger, I want the gun to shoot immediately or close to it as possible, but I also want to know what I'm looking at as close to real time as possible."

The lethal nature of a weaponized unmanned ground vehicle and the need to keep latency to a minimum are reasons that a robust connection from the operator to the remote weapon system is critical, whether that link is by radio, fiber or copper.

Testa said that when people hear about predator drones hitting their targets while the operator is halfway around the world, that may leave the impression that something similar can occur with remote weapons systems on the ground.

"They are using satellite communications with a fairly large latency," Testa noted of such drones. "We're shooting machine guns in a cluttered and asymmetric ground environment. That makes the problem a lot tougher in some ways. Drones are targeting for and launching one missile that has guidance to the threat. We are shooting dumb bullets at 10 per second, so we don't have a lot of wiggle room."

A futuristic vision of a fully autonomous robot that thinks and acts independently would essentially take human judgment out of the equation, and possibly without a real-time communications link to support supervised weapon operations.

The Ripsaw Unmanned Ground Vehicle prepares to engage targets with an M240B mounted on a wirelessly controlled CROWS while conducting Scout Gunnery Table VI at Fort Dix, New Jersey, in November 2013. (U.S. Army photo)

"Where we are with the weapons side today is tele-op; I need to be able to talk to my weapon," Testa said. "An autonomous UGV that could keep driving, increasing range, would lose that tele-op capability, in which case we would no longer have man-in-the-loop with the weapon—that is still unacceptable per DODD 3000.09. So currently we are constrained by radio function and that limits our range. Radio technology is also largely driven by the commercial market, and we need to keep an eye on our overall system cost."

Testa said remote weapon systems require relatively high bandwidth and a continuous flow of data to the RWS so that it doesn't result in continuous dropped messages, which could cause the system to reduce capability or shut down altogether.

"If a Soldier is engaging a threat to save himself and his buddies, he can't afford dropped messages to the point that the weapon often stops shooting," Testa said.

ARDEC engineers have been working on fiber and radio frequency extension kits that would increase the range of remote weapons systems.

"We believe that it's very hard for somebody to decipher our messages to the point where the enemy could turn our systems against us even if they are not overly encrypted," Testa said. "But we're not currently addressing encryption methods, and the development of these capabilities lies outside of the expertise of the ARDEC remote weapons branch.

"It doesn't mean certain degrees of encryption or jamming prevention couldn't or shouldn't be built in," he said. "It is not our focus right now nor is it core ARDEC mission. Our mission is to address how an RWS behaves when a cable is cut or RF messages are temporarily lost." The simple theory is, 'When you lose the link between the operator and the weapon, the system will stop doing what it's doing and won't start doing something it's not.'"

The technological sophistication of the enemy, or the theater of operations, would be factors to consider regarding encryption, jamming and frequency allocation, Testa said, but technical research dollars are too limited to engage in speculation about what a specific theater and battlefield scenario would require.

The ARDEC Remote Weapons Branch partners with other DoD organizations on the research, development and testing of technologies to add degrees of supervised autonomy for integration with advanced remote weapons systems. ■

AUTONOMOUS MOBILITY APPLIQUÉ SYSTEM

Autonomy-enabled technology provides a pathway to the future

BY BRUCE J. HUFFMAN, TARDEC PUBLIC AFFAIRS

Army engineers from the Tank Automotive Research, Development and Engineering Center at Detroit Arsenal, Michigan, are developing technology solutions for autonomy-enabled systems.

TARDEC and an industry partner, Lockheed Martin, demonstrated the Autonomous Mobility Appliqué System or AMAS at Fort Hood, Texas in January 2014.

Researchers transformed ordinary trucks from the Army's current vehicle fleet into optionally-manned vehicles, offering drivers new safety features and additional capabilities that never existed until now.

"These systems are designed, not to replace warfighters, but to help unburden them and augment their capabilities," said Bernard Theisen, TARDEC program manager for AMAS.

By installing kits onto a M915 tractor and two Palletized Loading System prime movers, the driverless trucks were able to negotiate oncoming traffic, follow rules of the road, recognize and avoid pedestrians and various obstacles and autonomously navigate through a maze of test areas.

The trucks were able to complete both complex urban and rural line-haul missions at low speeds.

Engineers challenged the system's capabilities even further by conducting a seven-vehicle unmanned line-haul mission at 40 mph at the Savannah River Site, South Carolina in May 2014.

During an AMAS Joint Capability Technology Demonstration, or JCTD, held there in August, the addition of Army and Marine drivers engaging in realistic combat scenarios further tested the capabilities of this new autonomy-enabled technology.

"The JCTD demonstrated the flexibility of the system, allowing drivers to choose from a continuum of features and capabilities starting with fully-manned operations; manned-operations with the addition of driver safety features and warnings; and the autonomous leader-follower mode," Theisen said.

The team also demonstrated additional capabilities such as tethered remote control and remote control operation.

"By delivering technologies that fill top priority capability gaps and improving the current vehicle fleet, our engineers and scientists are helping shape the Army of 2040 and changing the way Soldiers in the next generation will fight," said TARDEC Director Dr. Paul Rogers. "In today's fiscal environment, the wider lens of a long-range strategy will help the ground vehicle domain remain focused on delivering leap-ahead capabilities to the warfighter and help eliminate unnecessary costs associated with funding delays and periods of continuing resolution. The 30-Year Strategy also serves as a guide to help us choose our collaborative partners and technology investments more wisely."

TARDEC and its military and industry partners continued to test the capabilities of autonomy-enabled systems in August 2014 at Fort Benning, Georgia, combining unmanned air and unmanned ground vehicles to create a completely new capability to help ease the burden of resupplying Soldiers. In the Extending the Reach of the Warfighter through Robotics demonstration, an unmanned K-MAX helicopter transported an unmanned Squad Mission Support System ground vehicle via sling load, into a remote area presumed to be dangerous, and dropped it off for a resupply mission.

Using a sophisticated suite of sensors and satellite technology to guide it, the SMSS proceeded to a designated area where it delivered the supplies to the Soldiers who were waiting in the tree line. After completing the mission, the SMSS proceeded by remote control to higher ground, raised its mast and used its Gyrocam to conduct reconnaissance, sending video imagery back to the remote operator in real-time.

"This technology is giving us a greater capability for a resupply and provides us another way of tackling Soldier load," said Maneuver Battle Lab Deputy Director Eddie Davis. "If we can build a greater confidence level in the Soldiers that we're able to resupply them, they can take only what they need and we can take some of the burden off them."

TARDEC is also working with industry to develop and demonstrate autonomous shuttle systems with the hopes of someday efficiently transporting warfighters autonomously at military installations and bases. The Applied Research for Installation and Base Operations program is being tested at living laboratories such as the U.S. Military Academy, Stanford University and Fort Bragg, North Carolina.

"Maintaining a proper balance between current and future readiness is a key component moving forward," Rogers said. "The needs of the warfighter are driving the development of autonomy-enabled technologies, and the seeds of innovation have been planted. In the end, it's the collaborative partnerships we've developed and the continued teamwork that will enable that innovation to flourish." ■

CHEM-BIO DETECTION

Researchers gather feedback from robotic chem-bio sensor users

BY ECBC PUBLIC AFFAIRS

Soldiers entering a building suspected of chemical contamination are exposed to an unpredictable environment with potentially hostile forces. Inconclusive information makes it difficult to make timely decisions.

Army researchers are working on technology solutions to give Soldiers key information to keep them safe from chemical, biological, radiological, nuclear or explosives threats.

The future of chem-bio detection is wrapped in the evolution of technology, according to experts from the U.S. Army Edgewood Chemical Biological Center at Aberdeen Proving Ground, Maryland.

The center is demonstrating advanced detection equipment for sensitive-site assessments where a threat is likely, but remains unknown.

Robots survey sensitive sites remotely through an automated means known as Rapid Area Sensitive-site Reconnaissance, or RASR. An integrated system is equipped with a special sensor that uses a powerful near-infrared laser to scan for and identify potentially hazardous materials using Raman spectroscopy. The Avalon sensor can be mounted on an unmanned ground vehicle such as the iRobot PackBot 510, or be used by the warfighter as a hand-held detector.

"The mission space we're looking at is for sensitive-site assessments using a downrange chemical detection capability," said Matt Brown, extended user evaluation lead for the project. "We provided a complete RASR system to a Marine Corps unit and an Army unit for the past year."

The system is capable of rapid detection and identification of multiple liquid and solid chemicals of concern, including agents, precursors and degradation products.

Data collected has enabled the ECBC team to gather feedback directly related to the user experience.

In this case, ECBC operational managers identified critical touch points within each warfighter unit, which used RASR during training exercises designed to replicate scenarios in Afghanistan. Feedback included user interviews and surveys regarding two modes of operation: hand-held and robotic, and investigated the system capabilities and limitations, as well as ease of use, safety, operational tactics, techniques and procedures.

"Scientists and engineers may understand the technology behind the system, but the warfighters just want to know that it works effectively and is easy to use," said Doretha Green, technical manager of the RASR ATD. "Direct and honest feedback on the system is invaluable and taken into strong consideration in the development of the final product."

User evaluations are being compiled into a report for the RASR program manager, the Defense Threat Reduction Agency Joint Science and Technology Office and RASR transition managers within the Joint Program Executive Office for Chemical and Biological Defense for possible transition of the system into a future program of record.

The system provides additional situational awareness and improves the ability of highly trained reconnaissance teams to complete tasks in a CBRNE environment, Green said.

The U.S. Army Edgewood Chemical Biological Center featured the Rapid Area Sensitive-site Reconnaissance Advanced Technology Demonstration at the Team CBRNE Capability Showcase Aug. 5-6 where partners in government, industry and academia attended to learn more about chemical, biological, radiological, nuclear or explosives technologies.

A U.S. Marine uses an advanced detector in hand-held mode during a training exercise. Army researchers have collected valuable data from a year-long extended user evaluation. (U.S. Army photos)

"Systems like RASR can provide added functionality in austere environments, and greatly reduce the risk to personnel while still providing an accurate, real-time detection capability," she said.

The integration of a mapping sensor package onto the unmanned platform allows the UGV to autonomously map a contaminated area and provide a visual of the downrange site to the operator.

"The Avalon system contains a library of various chemicals and can match the chemical being targeted with what's in the library," Brown said. "The 4-pound detector gives the warfighter a standoff detection capability at a range of 0.3 to 3 meters. If there is an area that the robot cannot enter, the versatility of the system allows the user to dismount the Avalon and have the same functionality in hand-held operation as they would have if integrated on the robot."

ECBC has been involved in the RASR program since 2008.

"ECBC continues to work with partners across the military for integrated next-generation chemical detection solutions," Brown said.

POCKET INTELLIGENCE

Army researchers develop pocket-sized aerial surveillance device

BY JEFFREY SISTO, NSRDEC PUBLIC AFFAIRS

Researchers at the U.S. Army Natick Soldier Research, Development and Engineering Center are developing technologies for a pocket-sized aerial surveillance device for Soldiers and small units operating in challenging ground environments.

The Cargo Pocket Intelligence, Surveillance and Reconnaissance program, or CP-ISR, seeks to develop a mobile Soldier sensor to increase the situational awareness of dismounted Soldiers by providing real-time video surveillance of threat areas within an immediate operational environment.

While larger systems have been used to provide over-the-hill ISR capabilities on the battlefield for almost a decade, none deliver it directly to the squad level where Soldiers need the ability to see around the corner or into the next room during combat missions.

When Soldiers and small units need to assess the threat in a village, or in thick canopy terrain where traditional ISR assets cannot penetrate, the CP-ISR can be deployed to provide that capability.

"The Cargo Pocket ISR is a true example of an applied systems approach for developing new Soldier capabilities," said Dr. Laurel Allender, acting NSRDEC technical director. "It provides an integrated capability for the Soldier and small unit for increased situational awareness and understanding with negligible impact on Soldier load and agility."

NSRDEC engineers investigated existing commercial off-the-shelf technologies to identify a surrogate CP-ISR system.

Prox Dynamics' PD-100 Black Hornet, a palm-sized miniature helicopter weighing only 16 grams, has the ability to fly up to 20 minutes while providing real-time video via a digital data link from one of the three embedded cameras and operates remotely with GPS navigation. Tiny, electric propellers and motors make the device virtually undetectable to subjects under surveillance.

The size, weight and image-gathering capabilities of the system are promising advancements that fulfill the burgeoning requirement for an organic, squad-level ISR capability, but more work still needs to be done.

Several efforts are underway to develop three different aspects of the technology to ensure it is ready for the Soldier and small unit.

The first of these efforts is focused on a redesign of the digital data link to achieve compatibility with U.S. Army standards.

The second focuses on developing and integrating advanced payloads for low-light imaging, allowing for indoor and night operations.

Lastly, researchers are continuing to develop and enhance guidance, navigation and control, or GNC, algorithms for the CP-ISR surrogate system. This will allow the airborne sensor to operate in confined and indoor spaces, such as when Soldiers advance from room to room as they are clearing buildings.

In November 2014, NSRDEC will collaborate with the Maneuver Center of Excellence, the Army Research Laboratory and other organizations to support the Army Capabilities Integration Center's Manned Unmanned Teaming (Ground) Limited Objective Experiment by demonstrating the current capabilities of mobile Soldier sensors.

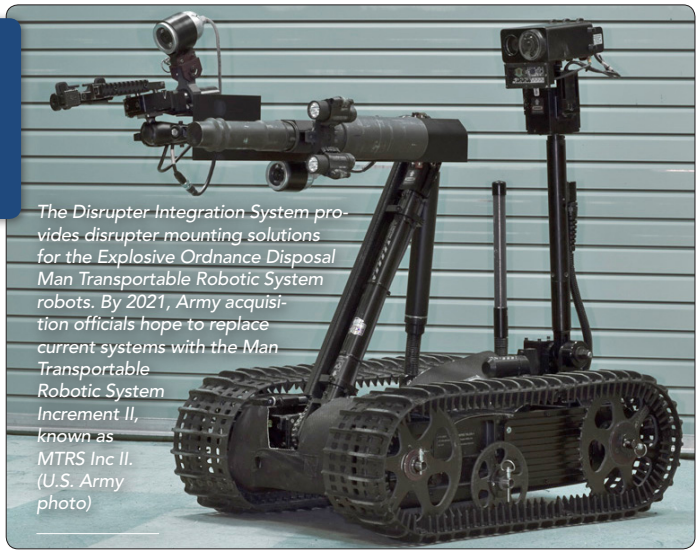
While the final system could be different from the surrogate system, NSRDEC officials said they are focused on proving the basic capability first. ■

A British Soldier holds a Prox Dynamics PD-100 Black Hornet, a palm-sized miniature helicopter weighing only 16 grams. (U.K. Ministry of Defense photo by Richard Watt)

GROUND ROBOTICS CAPABILITIE CONFERENCE AND EXHIBITION

Heidi Shyu, Assistant Secretary of the Army for Acquisition, Logistics and Technology, delivers keynote address

BY DAVID MCNALLY, RDECOM PUBLIC AFFAIRS



The Disrupter Integration System provides disrupter mounting solutions for the Explosive Ordnance Disposal Man Transportable Robotic System robots. By 2021, Army acquisition officials hope to replace current systems with the Man Transportable Robotic System Increment II, known as MTRS Inc II. (U.S. Army photo)

Future Army robotics systems will rely on open architecture, modular design and innovative concepts to perform missions from surveillance to wide area route clearance, according to Army officials.

"In the Army we always say, 'never send our Soldiers into a fair fight,'" said Assistant Secretary of the Army for Acquisition, Logistics and Technology Heidi Shyu said in the keynote address Aug. 13, 2014, to the National Defense Industrial Association Ground Robotics Capabilities Conference and Exhibition in Hyattsville, Maryland.

Hundreds of industry representatives, researchers and engineers gathered to identify technologies that will help meet future warfighter needs.

In 2004, the first full year of conflict in both Iraq and Afghanistan, the U.S. military deployed 162 robotic systems with a primary focus on explosive ordnance disposal, deterrence and removal. In the 10 years since, ground robotics in combat has grown exponentially. More than 7,000 systems are deployed overseas. The expanded mission portfolio includes route clearance, weaponization, chemical-biological detection and surveillance.

Shyu highlighted the six-ton M160 Anti-Personnel Mine Clearing System, which is designed for clearing mines in dynamic terrain like urban sites, fields, unimproved roads and muddy areas.

"This technology makes possible large-scale clearing and area neutralization operations rendering previously unusable roads and making them functional, and making possible missions in dynamic and contested environments," Shyu said.

More than 300 mini-EOD robots are in use in Afghanistan by U.S. forces at a cost of $35 million. The robots help to locate, identify and disarm explosive and combustible mechanisms to neutralize roadside bombs, car bombs and other improvised explosive devices.

"This dynamic robotic system is truly saving Soldiers' lives," Shyu said. "That is the power of robotics."

The U.S. military deployed more than 2,200 Talons to Iraq and Afghanistan over the past decade. The robots, although a mainstay for EOD operations, are now past their service life. Army officials plan a bridging strategy to provide additional non-standard robotics through 2021 when a new system will replace the Talon.

The Man Transportable Robotic System Increment II, known as MTRS Inc II, is a remotely operated, man-transportable robotic vehicle. The MTRS Inc II will provide a standoff capability to detect and confirm presence, identify disposition and counter hazards by providing a platform for payloads in support of current and future missions.

"This new system will address several shortfalls in terms of current capabilities today, namely the need for common chassis, or multiple mission payloads, which will reduce sustainment costs, logistics footprint and integration risks," Shyu said. "This vehicle will leverage an open-architecture framework as opposed to the current closed system and a common upgrade path.

"We are working with our industry partners to develop a standard architecture, which will enable us to incorporate future capabilities rapidly, keeping pace with rapid and dramatic commercial improvements in this area," Shyu said. "The proposed common robotics architecture will leverage platform independent autonomous ground vehicles and control of subsystems."

Army robotics architecture will use open-source software to enable broad support in the software development community.

"It will also take advantage of open standards for data transmission," Shyu said. "Our robotics modernization initiative will seek to leverage open architecture in a broad modernization strategy allowing us to take advantage of commercial advances and industry developments, while ensuring that robotics platforms are provided to our Soldiers at the lowest cost. We are at great pains to achieve cost savings wherever possible."

The future of ground robotics depends on the ability of robots to operate in diverse and constrained environments, she said.

"Commercial autonomous vehicles can maneuver very well in defined roadways where GPS and maps are available," Shyu said. "The Army has to navigate in diverse terrain, Including deserts, unpaved roads, rocky hillsides, jungles and urban terrain. We must also operate in adverse weather from snowy and icy conditions to sand-blown, triple-digit temperatures. In addition, we have to function in contested environments where jamming may occur. Efforts to overcome these challenges are essential. Nevertheless, despite tough operating environments, our robotics industry continues to innovate."

Shyu said the future of ground robots is one of unlimited potential.

"Our opportunities for invention and innovation are only limited by our creativity and our willingness to take risks and embrace new challenges to protect and enable our Soldiers," she said. ■

ARMY MATURES Autonomous Flight TECHNOLOGIES

Researchers developing and demonstrating autonomous flight technologies that promise to change the future of aviation

BY RYAN KEITH, AMRDEC PUBLIC AFFAIRS

Virtually all aircraft, from the Wright brothers first airplane at Kitty Hawk, North Carolina, to the unmanned aircraft systems employed in operations today, share a common component: Pilots. Whether in the cockpit or through remote control, pilots have remained a critical component to aviation, until now.

Researchers at the Aviation and Missile Research Development and Engineering Center at Redstone, Alabama, are developing and demonstrating autonomous flight technologies that promise to change the future of aviation.

TERRAIN-AWARE AUTONOMY

"With any helicopter, the strength of that platform is the ability to hover and operate in close proximity to the ground or obstacles," said Matt Whalley, Autonomous Rotorcraft project lead at AMRDEC's Aviation Development Directorate - Aeroflightdynamics Directorate. "To do that autonomously requires some new technologies—terrain sensors, navigation algorithms and programs that can look at the ground and find the safe landing spot."

Whalley said his group has been focused on that challenge for several years.

"We're trying to bolster those core technologies that would enable new types of operations or expanded operations with autonomous helicopters," he said.

The team developed a comprehensive small- and full-scale autonomous helicopter research capability using unique in-house skills in helicopter guidance and flight control, robotics planning and scheduling and emerging unmanned aircraft sensor technology.

Researchers validated software algorithms and further developed it into commercial software libraries, which led to distribution under a technology transfer agreement.

Whalley and his team demonstrated the scalability of the technologies and software by migrating the algorithms to AMRDEC's full-authority JUH-60A Black Hawk helicopter for flight testing.

In 2012, AMRDEC personnel successfully demonstrated low-level autonomous behaviors critical to the next generation of unmanned military rotorcraft. These behaviors include obstacle field navigation in complex and cluttered terrain and safe landing area determination.

"This was the first time terrain-aware autonomy has been achieved on a Black Hawk," said Lt. Col. Carl Ott, chief of the Flight Projects Office at ADD-AFDD.

Engineers conducted testing on the Rotorcraft Aircrew Systems Concept Airborne Laboratory, or RASCAL, a JUH-60A Black Hawk equipped with the H.N. Burns 3D-LZ laser detection and ranging system for terrain sensing.

"The RASCAL aircraft was the ideal platform to demonstrate this technology," said Jay Fletcher, RASCAL project manager. "It provides a fully programmable, fly-by-wire flight control system and [has] advanced sensor interfaces for rapid prototyping of new concepts while maintaining the standard UH-60 hydro-mechanical flight control system as a safety backup."

Additional tests followed, demonstrating key maneuvers, obstacles and other events that human pilots encounter and react to during flight, including avoid high-power lines and other aircraft, selecting a landing area and exiting from a box canyon.

The American Helicopter Society awarded its 2013 Alfred Gessow

Autonomous Technologies for Unmanned Aerial Systems demonstrates precision delivery to a handheld location beacon during an April 2012 test. (U.S. Army photo)

Award for a paper describing this effort, and Whalley received the RDA Outstanding Technical Leadership Award for guiding the government-contractor team.

ADD director Dr. Bill Lewis said the awards are a satisfying acknowledgement of a decade of cutting-edge autonomy research by AMRDEC engineers.

"The ARP team has led the world in developing Obstacle Field Navigation and Safe Landing Area Determination technology for rotorcraft," Lewis said. "Flight tests on AMRDEC RASCAL JUH-60 have conclusively demonstrated mission level benefits of these technologies for Army rotorcraft and pave the way for future implementation on production aircraft."

During an August 2014 training exercise at Fort Benning, Georgia, an unmanned K-MAX helicopter sling loads an unmanned Squad Mission Support System loaded with supplies. (Courtesy photo by Glenn Helm, Lockheed Martin)

UAS AUTONOMY

Through a Joint Capability Technology Demonstration sponsored by the Office of the Secretary of Defense, AMRDEC is integrating, flight testing and demonstrating improved autonomy products on the unmanned K-MAX power lift helicopter.

The Autonomous Technologies for Unmanned Aerial Systems JCTD addresses a requirement identified by the U.S. Central Command for a cargo unmanned aircraft system that can quickly, safely and accurately deliver mission critical and time sensitive resupply to Soldiers on the ground.

Sara Condon, the ATUAS JCTD technical lead at the ADD - Aviation Applied Technology Directorate, said that high threat environments and difficult terrain present numerous challenges for resupply.

"Unimproved roads and inhospitable terrain force ground convoys to carry smaller, lighter loads and travel at slower speeds," Condon said. "This lack of speed and predictable routes make movements susceptible to improvised explosive device attacks."

While utility and cargo helicopters address many of these concerns, Condon said the limited number of these kinds of vehicles forces commanders to choose between conducting logistical resupply missions or operational support missions. Also, resupply operations in extreme heat and high altitudes reduce the cargo carrying capacity of the aircraft resulting in the need for additional sorties to meet Soldiers' resupply needs.

The ATUAS has the capability to fly multiple-load in-stride cargo delivery missions or single location retrograde missions, when properly configured, while continually providing situational awareness feedback to a ground control station operator.

"During delivery operations, the aircraft autonomously identifies obstacles, selects safe drop-off locations, avoids obstacles, drops off loads and departs," Condon said. "During retrograde operations the aircraft autonomously locates the retrograde load, identifies and avoids obstacles, maneuvers over the load, connects to the load and departs."

The aircraft uses GPS to guide it in the general cargo delivery area. When the UAS is within 300 meters of the target, a beacon provides flight guidance to the flight control computer. As the aircraft maneuvers within the field of view of the camera, more precise guidance is provided to the aircraft as to the exact cargo drop-off location.

AMRDEC senior aerospace engineer Mohammadreza Mansur said the greatest challenge was developing the system for the high-altitude, high-turbulence and high-wind environments that the helicopter would face in Afghanistan. He developed and validated an extensive simulation-modeling suite and was responsible for the analysis and optimization of a complex core flight control system.

"Even though the aircraft is flying autonomously, a pilot was on board [during flight tests] to control the aircraft if the control laws were not doing what they were supposed to do. Their comments were: 'The aircraft flies the way I would.' It's the best comment you can get from a flight-test pilot," he said.

Mansur received an RDA Outstanding Achievement Award for the design and flight test development of flight control laws for the unmanned K-MAX helicopter.

During Mansur's two years of work, the project emerged from a developmental program, to demonstration flight tests and deployment. In December 2011, K-MAX became the first unmanned aerial system to deliver cargo in-theater for the U.S. Marine Corps. Two aircraft deployed for a six-month demonstration period that was extended to two and a half years.

Capt. Patrick Smith, the U.S. Navy's Cargo UAS program manager, praised the performance of the aircraft during a July 2014 teleconference with reporters. "[They] excelled beyond anything I thought possible," he said.

Lewis said the AMRDEC teams are happy and excited to have been critical to the unprecedented operational success of the unmanned K-MAX in Operation Enduring Freedom.

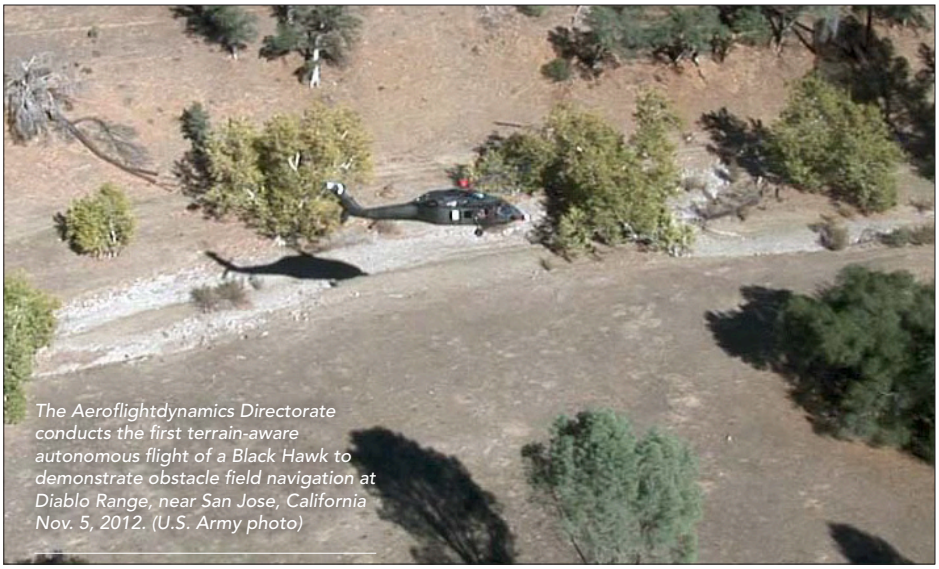
"Working closely with Lockheed Martin and Kaman Aerospace, ADD-AFDD developed the flight control software at the heart of the unmanned K-MAX," Lewis said. "Receipt of the 2012 RDA Award acknowledges not only the high quality of this outstanding technical achievement, but the potential for aviation S&T to directly benefit the warfighter."

Meanwhile, the ATUAS JCTD continued to develop, integrate and demonstrate added autonomous capabilities. In fiscal 2012, the team demonstrated, certified, and transitioned the beacon system for the Marine Corps Cargo Unmanned Aerial System deployment. The team initiated integration of autonomous delivery beyond line of sight, autonomous enroute re-programming, in-stride multiple drop locations and control of two vehicles for a single ground control station.

During the second technical demonstration in 2013, the team demonstrated an enhanced electro-optical infrared capability for operator situational awareness, obstacle avoidance, safe sling-load delivery area determination, dynamic route re-planning and other capabilities.

The ATUAS Program Office is planning additional follow-on efforts, including further experimenting with multi-vehicle control and mission planning.

In August 2014, Lockheed Martin and the Tank Automotive Research, Development and Engineering Center successfully conducted a fully autonomous resupply, reconnaissance, surveillance and target-acquisition demonstration using TARDEC's Squad Mission Support System unmanned ground vehicle, K-MAX unmanned helicopter and Gyrocam optical sensor. During the a capability assessment to extend the reach of the warfighter through robotics, K-MAX delivered SMSS by sling load to conduct an autonomous resupply mission scenario for Soldiers defending a village robotics at Fort Benning, Georgia.



The Aeroflightdynamics Directorate conducts the first terrain-aware autonomous flight of a Black Hawk to demonstrate obstacle field navigation at Diablo Range, near San Jose, California Nov. 5, 2012. (U.S. Army photo)

FUTURE VERTICAL LIFT

The Future Vertical Lift initiative will develop the next generation of vertical lift aircraft for the joint warfighter. FVL has three main tenets: to improve aircraft performance, survivability, and to significantly reduce operating costs.

Aircraft must be able to fly farther and faster, carry heavier payloads, be easier and less expensive to sustain, team with unmanned systems, and perform certain optionally-piloted missions.

"AMRDEC is currently leading the development of the Future Vertical Lift family of aircraft, all of which are required to be either optionally piloted or fly autonomously," Lewis said. "This once impossible task is now just the next step."

The history of military aviation is highlighted by the exploits of great pilots. Lewis, himself a retired Army aviator, envisions a future where pilots manage aircraft and the systems contained therein as autonomous technologies continue to evolve. ■

GENERAL DYNAMICS LAND SYSTEMS

Robotic Solution Lightens Soldiers Load

General Dynamics Land System's Multi-Utility Tactical Transport (MUTT) is a semi-autonomous robotic follower that lightens the load for Soldiers by decreasing the amount of equipment they need to carry when dismounted in the toughest of terrains.

The MUTT uses advanced, proven commercial technology that has been adapted for the rigors of the battlefield. With ultra-quiet electric motors, the MUTT gives Soldiers unmatched internal transportability options and expeditionary power that includes hands-free, robotic platform operation and an optional tracked suspension system.

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GENERAL DYNAMICS
Land Systems

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INSECTS

Army researchers find inspiration in nature

BY JOYCE P. BRAYBOY, ARL PUBLIC AFFAIRS

Army researchers are finding they have much to learn from bees hovering near a picnic spread at a park.

Dr. Joseph Conroy, an electronics engineer at the U.S. Army Research Laboratory, part of the Research, Development and Engineering Command, works with robotic systems that can navigate by leveraging visual sensing inspired by insect neurophysiology.

A recently developed prototype that is capable of wide-field vision and high update rate, hallmarks of insect vision, is something researchers hope to test at the manned and unmanned teaming, or MUM-T exercise at the Maneuver Center of Excellence, Fort Benning, Georgia. This project will give us a chance to implement methods of perception such as 3-D mapping and motion estimation on a robotics platform, Conroy said.

The Maneuver Center of Excellence exercise will test whether ARL's robotics platform is on track with the Army's vision to team a robot with a Soldier. The tests will help to inform ARL researchers on how Soldiers might utilize information that can be provided by these platforms while attempting to clear a building from a safe distance in an urban environment, Conroy said.

The military's goal of teaming autonomous systems with Soldiers requires collaboration among a variety of researchers from within ARL and outside, including Carnegie Mellon University researchers, who have been the primary collaborators for this project.

Carnegie Mellon is part of the Micro-Autonomous Systems Technology Collaborative Technology Alliance of ARL's robotics enterprise, which explores ways to enhance Soldiers' situational awareness on the battlefield through basic research on micro-scale robotic systems.

The MAST CTA is led by BAE Systems, with principal members — the Jet Propulsion Laboratory, University of Maryland, University of Michigan and University of Pennsylvania and 13 other university consortium members.

"The upcoming tests are a small example of a much larger effort," said Brett Piekarski, Collaborative Alliance manager. "The university researchers across the consortium work with the Army researchers to come up with systems that can provide Soldier/robot teaming and be transitioned to industry."

The prototype is designed to help Soldiers have tactical awareness at the squad and personal level in urban and complex environments.

"If our prototype operates in the way it was designed to during these tests, it would be a technical win," Conroy said. "But I would say the real goal of this exercise is to put the technology in the hands of Soldiers, gather their feedback, and gain understanding about what will make autonomous systems more useful."

The components of the quad rotor are a mix of commercial and custom-designed parts to develop the navigation, exploration and mapping necessary for military applications, said Brendan Byrne, who manages the platform from the perspective of Computational and Information Sciences.

"Carnegie Mellon has previously demonstrated many of the capabilities that we will require for this project in a controlled environment, however, we are testing 3-D mapping and localization in a large, unstructured environment," Byrne said.

ARL has been working with the CMU team for about two years, but only for the last nine months for the MUM-T exercise, Byrne said.

Issues can be uncovered when ARL engineers probe weaknesses in experimental setups that have been previously used to demonstrate capabilities in controlled environments. Further collaboration with university researchers can address these issues and produce a far more robust system.

These nano-quads are the size that Army researchers envision. The current size is about as compact as a microwave oven. (Photo courtesy of KMel Robotics)

The university researchers addressed the issues and came back with a far more robust algorithm, he added. "Just yesterday we were flying it through the building, zipping up and down stairwells."

ARL is interested in stretching the boundaries of what will be feasible for Army unmanned system doctrine. The lab's novel technology will be the least mature platform represented at MUM-T.

"We take a crack at unsolved problems," Byrne said. "The technology may not completely work, but it directs where our attention should be focused."

Today, human/robot teaming requires a lot of hands on participation from the Soldier but this platform is designed to navigate through a 3-D maze and avoid obstacles without help, he said.

MUM-T will be the first time ARL has demonstrated the technology in a more operational environment.

"It is exciting, Byrne said. "On one hand, the technology offers the most cutting edge possibilities. On the other hand, the lack of maturity makes it the most prone to failure."

Over the past few decades there has been much interest in this class of flying robotic platforms known as micro-air vehicles. The palm-sized vehicles operate relatively low to the ground, and are capable of navigating indoors or outdoors with stealth, low cost and low operator workload.

Engineers begin looking to insects because of the robust navigation in uncertain environments. In particular, Conroy became interested in the insect capability of detecting and tracking small targets and their capability for perceiving structure of the environment without stereo vision.

Conroy and his colleague J. Sean Humbert from the University of Maryland detailed their findings in "Structure from Motion in Computationally Constrained Systems."

Army researchers address the challenge of Soldier/robot teaming at the squad level. (U.S. Army photo)

He said one of the things he is eager to test at MUM-T is the robotic mimicking of active vision in insects, which is their intentional use of motion to perceive structure.

The Research, Development and Engineering Command also has near-term focused organizations like the U.S. Army Communications-Electronics Research, Development and Engineering Center, Tank Automotive Research, Development and Engineering Center and Natick Soldier Systems Center, that will demonstrate state-of-the-art equipment at MUM-T the Army is developing.

The Maneuver Center of Excellence conducts research, development and experimentation to ensure the future maneuver force is prepared and equipped to fight and win in a complex future environment.

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WEARABLE TECHNOLOGY

Soldiers of the future will generate their own power

BY JEFF SISTO, NSRDEC PUBLIC AFFAIRS

Wearable technologies may provide U.S. Soldiers with on-the-move, portable energy and reduce the weight of gear they carry into combat.

Researchers at the Natick Soldier Research, Development and Engineering Center are developing Soldier-borne energy harvesting technologies.

During the Maneuver Fires Integration Experiment, or MFIX, a combined, multi-phase joint training exercise held in September 2014 at Fort Benning, Georgia, researchers tested prototype energy harvesting technology solutions.

"My initial impression is that they fulfill a need for instant power generation on long-range missions when displaced from traditional resupply methods," said Sgt. 1st Class Arthur H. Jones, an infantryman with the Maneuver Center of Excellence who participated in the demonstration.

A sharp rise in Soldier-worn power capabilities has resulted in a dramatic increase in the number, variety and weight of batteries carried by warfighters in the field.

This weight prompted NSRDEC researchers to begin developing and evaluating small, lightweight, efficient, on-the-move, portable energy harvesting and distribution systems that eliminate the need to carry extra batteries.

Energy harvesting works by capturing small amounts of energy that would otherwise be lost as heat, light, sound, vibration or movement. It uses that energy to recharge batteries and provide power for electronic devices such as a Soldier's communication equipment, sensors, or battlefield situational displays.

Researchers first demonstrated the concept to Army and government representatives at Fort Devens, Massachusetts, in April 2014. The demonstration consisted of experienced Soldiers wearing three energy harvesting devices while traversing a four-mile course that included hard surfaced roads, lightly wooded areas, open fields and hilly terrain.

The technologies, which included wearable solar panels, backpack and knee kinetic energy harvesting devices, are now being tested at MFIX as ways to reduce the weight and number of batteries Soldiers must carry to power electronic devices.

Lightning Pack's Rucksack Harvester relies on the weight of the backpack to produce kinetic energy when the backpack oscillates vertically in response to the Soldier's walking or running stride. As the backpack is displaced vertically, a rack attached to the frame spins

a pinion that, in turn, is attached to a miniature power generator. It is capable of producing 16 to 22 watts while walking and 22 to 40 watts while running.

Bionic Power's Knee Harvester collects kinetic energy by recovering the power generated when walking. The articulating device is attached to both the upper and lower part of each leg and extracts energy when the knee is flexed. Through software control, the knee harvester analyzes the wearer's gait and harvests energy during the phase of the stride when negative work is being performed. This attests that the Soldier is exhibiting less metabolic activity descending when compared with descending without wearing the device.

MC-10's photovoltaic, or PV, Solar Panel Harvester operates by converting sunlight into electrical energy. The panels, which cover a Soldier's backpack and helmet, are constructed from thin gallium arsenide crystals that provide flexibility to the panel's material and allow it to conform to a Soldier's gear. Under bright sunlight conditions, with the PV panel facing the sun, the backpack panel is capable of delivering 10 watts while the helmet cover panels provides seven watts of electrical power.

At MFIX, NSRDEC researchers collected power management data and assessed user feedback from the Soldiers wearing the technologies. Once the energy harvesting technologies themselves are validated, the next step will be to sync with the Integrated Soldier Power Data System as a way to distribute the energy to a Soldier's electronic devices.

Additionally, "MFIX is looking at new concepts with energy harvesting devices and how they fit in a tactical environment," said Noel Soto, project engineer, Power and Data Management Team of the NSRDEC Warfighter Directorate.

A Soldier conducts dismounted maneuvers wearing Lightning Pack's Rucksack Harvester, Bionic Power's Knee Harvester and MC-10's photovoltaic, or PV, Solar Panel Harvester during an energy harvesting technology demonstration at Fort Devens, Massachusetts. (U.S. Army photo David Kamm)

"MFIX is an important opportunity that allows us to quantify the energy harvesting technologies that generate Soldier power on the move," said Henry Girolamo, lead, Emerging Concepts and Technologies, Warfighter Directorate, who has been involved with the effort since 2011. "The MFIX Data collected in the experiment will inform us of the power harvester efficiency by comparing energy harvester equipped Soldiers and non-energy harvester equipped Soldiers and states of charge from the energy harvesters versus discharge from non-energy harvester equipped Soldiers."

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Ethicist challenges researchers to consider the implications of future autonomous robots

SEEKING THE ETHICAL ROBOT

Army Research Laboratory challenges researchers to consider the implications of future autonomous robots

BY DAVID MCNALLY, RDECOM PUBLIC AFFAIRS

Scientists and engineers from the U.S. Army Research Laboratory gathered Sept. 10, 2014, to discuss ethical robots.

Dr. Ronald C. Arkin, a professor from Georgia Tech, roboticist and author, challenged Army researchers to consider the implications of future autonomous robots.

"The bottom line for my talk here and elsewhere is concern for noncombatant casualties on the battlefield," Arkin said. "I believe there is a fundamental responsibility as scientists and technologists to consider this problem. I do believe that we can, must and should apply this technology in this particular space."

Arkin said he believes lethal autonomous weapons systems can lead to the potential saving of noncombatants, if properly developed and deployed.

"I wish these systems never had to be built. I wish we never had wars," Arkin said. "But clearly there is a need for this technology to protect our national interests. But at what cost?"

Arkin encouraged researchers to reduce collateral damage that can occur by including ethical considerations in the design of robotics systems.

Lethal autonomy is inevitable he said. As examples, he listed cruise missiles, the U.S. Navy Aegis-class cruisers, Patriot missiles, fire-and-forget systems and even land mines by certain definitions.

"Could we create autonomous systems to potentially outperform human warfighters with respect to compliance to international humanitarian law or the Geneva Convention?" Arkin asked. "I'm not saying it's easy. I'm not saying it's around the corner. What I am saying is that it should be a topic of research."

Human failings abound throughout history when it comes to war crimes and atrocities, he said.

"Don't we have a responsibility as scientists to look for effective

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ways to reduce man's inhumanity to many through technology?" Arkin asked. "Research in ethical military robotics could and should be applied toward achieving this end. I believe we can make a difference in this."

Arkin suggested that the solution would require risk taking on the part of management, dedication and consideration of "very hard problems."

"How can we make it in the last few seconds when it's approaching a target and it sees something that doesn't look right, a school bus, or whatever, where you don't have time to call home and make that particular decision?" he asked.

Arkin said the events of 9-11 still disturb him.

"There is no reason on earth that we should have ever allowed an aircraft to fly into a building," he said. "It doesn't take that much technology if you're on a collision course and alarms are going off…to be able to make the aircraft gain altitude and usurp authority from the human. Sometimes, machines know better."

One of the professor's objectives is to ensure robots possess an ethical code. Arkin said robots should be provided with the right of refusal for unethical orders.

"These systems are embedded with troops as organic assets and will work alongside the warfighter," he said. "I don't know how to program a robot to be good, but I do know how to put in constraints into these systems, which will enable it to refuse under certain circumstances."

Arkin expressed optimism for the future; however, he said, "There is no way we are going to be able to inculcate these systems with the moral reasoning of human beings any time soon. Not possible."

Instead, Arkin advocated finding narrow, limited circumstances where roboticists can define the appropriate actions, such as room clearing, counter sniper operations and perimeter protection.

"For a whole bunch of reasons, we should not create robot armies even if it were possible," Arkin said. "We need humans in the battlespace to understand how horrible war can be."

Arkin began researching ethical robots in 2006 with a grant from the Department of Defense. He has published multiple papers on the topic as well as authoring a book, "Governing Lethal Behavior in Autonomous Robots."

"The introduction of new technologies to society often comes with challenging ethical questions," said Army researcher Christopher Kroninger, who attended the colloquium. "This was a great exploration of a particularly thorny issue. It was certainly a provocative topic. I'd say the primary line of discussions in the conversations I participated in regarded what sorts of behaviors might prompt more ethical decision making on the battlefield and what governs the role of acceptance of intelligent systems in society."

Roboticist Philip Osteen, an ARL contractor working in the Autonomous Systems Division, also attended the presentation.

"Researchers have a tendency to focus on specific goals to the point of having tunnel-vision, so while it is important to hear talks from researchers working in the same domain," Osteen said. "It is also essential to hear talks that make us think about the broader implications of our work."

Osteen said Arkin's presentation achieved its goal.

"It was thought-provoking and refreshing in its inclusion of results from an array of different research fields," Osteen said.

ARL offers frequent colloquiums, or academic seminars led by a different lecturer on a different topic at each meeting. The events are streamed live over the Internet to interested researchers across the U.S. Army Research, Development and Engineering Command. ■

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GVR-Bots to act as research platforms

TARDEC's new robot, completely government-owned, maximizes platform flexibility with modular architecture for easy upgrades that are more affordable. The new GVR-Bot originated when TARDEC engineers began replacing the internal electronics and software of approximately 20 PackBot 500 and 510 robots with government-designed and -owned software and hardware. The GVR-Bot and its Interoperability Profiles V2-compliant, open-architecture design will be used by sister organizations in the Army research community.

A few years ago, when the cost of production and sustainment was high, the Robotics Systems Joint Program Office began a program to standardize both the PackBot and the TALON, according to Ty Valascho, an electrical engineer in Ground Vehicle Robotics.

"GVR received the portion of the project to standardize the PackBot," Valascho said. "While the project was going on, the Army decided they would no longer support the PackBot standardization. We decided we would turn the program into a research platform."

Valascho said TARDEC will work with SBIR partners, ARL and any other interested groups that use robots.

"We have a government-owned design that we can build in-house," he explained. "Eventually, we think we can make them into kits, and organizations can build their own."

Valascho said one of the issues that contributed to the high cost of PackBot maintenance was that the inner workings were all one big piece. If something broke, the entire assembly/component had to be replaced. To combat that cost, TARDEC engineers have replaced the one-piece system with smaller, more affordable replacements – a distributed architecture.

"We broke it down into a lot of little pieces," said Valascho. "If anything breaks, you can trouble-shoot it down to that one part and bring the cost of maintenance down a lot. That was the primary driver for it all."

The second goal of the original program was to standardize the PackBot's interface to allow for the use of different payloads.

"A third-party vendor could make a new sensor or arm and integrate it in," Valascho said. "The GVR-Bot is government-owned inside and out, so if you need a new sensor or a new feature, it can be done."

As a completely government-owned design, changing pieces on the robot becomes a much easier procedure.

"In this whole process, we are doing work that a contractor would usually do," explained Valascho. "As a research organization, we tend to focus on our narrow interests. We now have the ability to do that research and apply it to the base platform, where it can benefit everyone."

He continued, "We can build them in house, we design them in house, all the parts are in house. That solves quite a few problems for us... if there is a problem, or if we have to change direction, it is just us in this room."

Ty Valascho, an electrical engineer in TARDEC's Ground Vehicle Robotics group, tests the organization's new GVR-Bot, repurposed PackBot 500 and 510 robots with government-owned components inside and out. (U.S. Army photo)

Army research team recognized at international nanotechnology conference

Researchers from ARL received the best conference paper award at the 14th IEEE International Conference on Nanotechnology held in Toronto, Canada, Aug. 18-21, for their paper entitled "Gold Nanocluster-DNase 1 Hybrid Materials for DNA Contamination Sensing." Team members shown (left to right) are Dr. Mark Griep, WMRD; Dr. Abby West, WMRD; Dr. Dan Cole, VTD; and Dr. Shashi Karna, WMRD.

Army announces new RDECOM command sergeant major

The U.S. Army announced that Command Sgt. Maj. James P. Snyder will assume duties and responsibilities as the command sergeant major for the U.S. Army Research, Development and Engineering Command at Aberdeen Proving Ground, Maryland, from outgoing Command Sgt. Maj. Lebert O. Beharie.

RDECOM ensures the dominance of Army capabilities by empowering, unburdening and protecting the Joint Warfighter through integrated research, development and engineering solutions. The command has more than 14,000 civilian researchers, engineers and support personnel.

Snyder will serve as the senior enlisted advisor to the commanding general and provide unique insights into ongoing science and technology efforts.

The ceremony date and location are still to be determined. Snyder currently serves as the command sergeant major of the 3rd Combat Aviation Brigade at Hunter Army Airfield, Georgia.

Snyder has served in every position from crew chief to command sergeant major during his career field. His assignments include Fort Campbell, Kentucky, Katterbach, Germany, Camp Eagle, Korea and Hunter Army Airfield, Georgia.

Snyder's deployments include Bosnia-Herzegovina, Operation Iraqi Freedom I and III, as well as, Operation Enduring Freedom VIII and X.

Synder, a native of Ridgeville, Indiana, joined the U.S. Army in August 1990 and became an AH-64 Attack Helicopter repairman.

Robotic Systems Testing Underway at Tobyhanna

Army engineers are testing robotic unmanned ground vehicles in an effort that could bring future robotics work to Tobyhanna Army Depot, Pennsylvania.

The Unmanned Ground Vehicles program manager selected Tobyhanna to conduct a proof-of-concept for potential upgrades to the Army's medium-class robotics fleet.

Response to urgent warfighter needs in recent conflicts left the U.S. Army with a mixed fleet of systems and high sustainment costs. In the future, the Man Transportable Robotic System's second increment, known as MTRS Inc II, the Army will move to one unmanned ground vehicle with a single configuration.

Electronics technicians in the Communications Electronics Command Communications Systems Directorate are removing all proprietary components in prototype vehicles and replacing them with government-designed components. This allows the Army to compete purchases of replacement parts in the future. Additional changes include replacing the heavy control units with much lighter ruggedized computers running government-designed software.

Chase Gardner, electronics engineer in the Production Engineering Directorate, said success with this effort could lead not only to additional MTRS systems, but other robot overhaul programs as well.

"If we perform well with this project run, it could lead to the production of about 1,200 MTRS kits," Gardner said, adding that further success could lead to obtaining more Army ground robotic systems overhaul workload. This is the second robotics project performed by Tobyhanna, following the iRobot unmanned ground vehicle mission.

Man Transportable Robotic Systems represent common, remotely-operated, tracked vehicle platforms designed to perform buried mine detection, engineer route clearance, special operations and explosive ordnance disposal missions. Each unit weighs roughly 120 pounds and has a range of 800 meters, providing safety and security for warfighters operating the systems in combat zones.

To prepare for MTRS testing, electronics worker Nicholas Prehotsky and James Serafin, an electronics mechanic, received systems operations training from robotics team personnel at Picatinny Arsenal, N.J., Prehotsky has conducted testing on several MTRS systems and recognizes the robot's many capabilities.

"The MTRS robots come equipped with a long list of benefits to Soldiers," Prehotsky said. With four video cameras, a 200-pound towing capacity, and ease of use, these robots present a "highly-innovative solution for warfighters to stay out of harm's way."

During developmental testing, Prehotsky and Serafin control the MTRS from a remote control unit and measure the maximum distance the system can operate before going out of range. Serafin said the process is simple but crucial to the mission—especially for bomb and chemical disposal activities.

"Without an accurate measurement of the system's range, there could be adverse effects once the system is deployed to theater," said Serafin. "Although this is the first phase of the program, we're taking every step to overcome challenges and prepare for any additional robotics programs that may come to Tobyhanna."

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