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FOCUS: LETHALITY

+PLUS

INTERVIEW WITH

SERGEANT MAJOR OF THE ARMY RAYMOND F. CHANDLER III

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DEPARTMENTS

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
ATEC	Army Test and Evaluation Command
DARPA	Defense Advanced Research Projects Agency
DASA(R&T)	Deputy Assistant Secretary of the Army for Research and Technology
PEO MS	Program Executive Office Missiles and Space
PEO Soldier	Program Executive Office Soldier
SMDC	Space and Missile Defense Command

On the cover: *U.S. Army Rangers assigned to 2nd Battalion, 75th Ranger Regiment, fire a Carl Gustav 84mm recoilless rifle at Camp Roberts, Calif., Jan 26, 2014. Rangers use a multitude of weaponry during their annual tactical training. (U.S. Army photo by Pfc. Rashene Mincy)*

Front Cover: *Design by Chris Boston with photo by Pfc. Rashene Mincy.*
Back cover: *Design by Joe Stephens with photo by Erin Usawicz.*

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http://armytechnology.armylive.dodlive.mil

The Army of the future will have fewer Soldiers but will be more lethal. Technology will make that possible, and our scientists and engineers are—and have been—redefining the art of the possible to make this enabling technology a reality.

The Soldier and squad are the foundation of the Army. Our strategy is to build from the Soldier out, equipping our squads for tactical overmatch in all situations. They will connect to an integrated network to give them greater awareness and increased speed for decision-making beyond their adversaries, and they will operate in vehicles that make them more mobile, more lethal, and at the same time, better protected.

The U.S. Army Research, Development and Engineering Command is bringing solutions to these challenge at every point. From aviation to ground vehicles, our researchers and engineers are developing and testing the best technologies to make ground and air vehicles more protective of our Soldiers while providing increased efficiency, affordability and lethality.

Our researchers are constantly on the hunt for improving our weapon designs to pack more punch into our rockets, artillery and mortars. We apply knowledge gained from a powerful new avenue of science, disruptive energetics, to get a bigger bang out of a smaller package.

Energetics research holds the promise of a tenfold increase in range and explosive punch through new materials and chemical compositions. Imagine being a commander in the field with 10 levels of scalable lethality. Options increase exponentially. A strike need only be as lethal as necessary to accomplish the mission. As our sensors, targeting and associated technologies match our improvements in lethality, commanders will have fine-grained control to minimize if note completely avoid collateral damage.

The Army invests about $250 million annually in lethality research and development. Much of this funding goes to Army Research Laboratory, the Aviation and Missile Research, Development and Engineering Center and the Armament Research, Development and Engineering Center. A lot of emphasis goes to our partners at the U.S. Amy Space and Missile Defense Command, where they are developing the High Energy Laser Mobile Demonstrator. This innovative concept uses directed energy to achieve what can only be described as sci-fi results.

Lethality research is not just about more options to strike. It's also about increased security for our base camps. Our air defense science and technology initiatives include counter unmanned aerial surveillance/cruise missile and counter rockets, artillery and mortar systems.

The Army is seeking affordable extended range precision technologies for current and future weapon systems. We will continue our efforts to meet the Chief of Staff of the Army's strategic priorities to provide our Soldiers with precision long-range fires, defense against threats, guidance in GPS-denied environments and new technologies for propulsion and warheads.

I am confident that our success on the R&D side will provide greater force protection and ensure survivability across all operations. It will also create operational overmatch through enhanced lethality and accuracy. Finally, it will reduce lifecycle cost of future Army capabilities.

This research is vital if we are to have a smaller footprint with greater than or equal lethality. We must develop the options through science and technology investigations. We owe it to our Soldiers to do everything we can. As we deliver technology solutions designed to empower, unburden, sustain and protect, we will provide our Soldiers with the decisive edge.

Dale A. Ormond
Director, RDECOM

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On a personal note, this will be my final column. The Army announced my reassignment to the position of deputy assistant secretary of the Army (Plans and Resources) in the Office of the Assistant Security of Army (Manpower and Reserve Affairs).

I know the RDECOM workforce will continue to do great things for the Army and for the command. I have wholeheartedly enjoyed serving you, a world-class workforce, as the director of RDECOM. I truly believe in the potential and capability of this enterprise as a national asset. What you do every day directly empowers, unburdens and protects Soldiers and because of that, and you have the best job in the world.

ARMY TECHNOLOGY

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The Best Weapon in the U.S. Army

Q&A WITH SERGEANT MAJOR OF THE ARMY RAYMOND F. CHANDLER III

Sergeant Major of the Army Raymond F. Chandler III was sworn in as the 14th Sergeant Major of the Army March 1, 2011. He has held leadership positions from tank crewman to command sergeant major. Chandler serves as the Army chief of staff's personal adviser on all enlisted related matters, particularly in areas affecting Soldier training and quality of life. Chandler entered the Army in September 1981 and became an armor crewman. Chandler served in all tank crewman positions and had multiple tours as a troop, squadron and regimental master gunner. He has served in the 1st Infantry Division (Forward), 2nd Infantry Division, 4th Infantry Division, 1st Cavalry Division, 3rd Armor Division, 2nd Armored Cavalry Regiment, 3rd Armored Cavalry Regiment, U.S. Army Armor School, and the U.S. Army Sergeants Major Academy. He also served as a first sergeant in four detachments, troops and companies. He served as operations sergeant major in 1/2 ACR, and as command sergeant major in 1/7 Cavalry, 1st Cavalry Division (Operation Iraqi Freedom II 2004-2005); U.S. Army Garrison Fort Leavenworth, Kan.; and the U.S. Army Armor School. He was assigned as the U.S. Army Sergeants Major Academy command sergeant major in December 2007. In June 2009, he became the 19th commandant of USASMA and the first enlisted commandant in USASMA history. He has a bachelor of science in public administration from Upper Iowa University.

Army Technology: Even with all the firepower and lethality science and technology can offer, what is the Army's best weapon?

Chandler: The best weapon we have in the Army is still the U.S. Soldier. He or she is also the most precise weapon that the Army has because of a combination of skills, experience and knowledge. A combination of the technology and the Soldier makes us superior on the battlefield and that's what makes the Army strong.

Army Technology: How have you seen lethality evolve during your Army career?

Chandler: I'm a tanker by background, and when I came into the Army in 1981, I was on an M60A3 Passive Tank, and then I got upgraded to an M60A3 Thermal. When I went to Fort Carson after three years in the Army, I was on a 1964 model year tank. There was the onset of M1 series, then the Bradley series. Digitization has been one of the most significant upgrades that we've made in Armor. I can recall being at Fort Hood in the 4th Infantry Division when Force XXI came about with its digitization. However, I believe we need to do a better job of exercising digitization in the Army—we've only scratched the surface. There's much more that we can do.

If you look at something as simple as gunnery for Bradleys and tanks, we don't force the system to use the full capabilities of the Bradley of Abrams to ensure we place accurate and timely fires to utilize the capabilities of the architecture that is in the systems.

Army Technology: Do you see the role of Armor changing as we focus on increasing Soldier and squad lethality?

Chandler: I think we have a pretty good platform now in the Armor community with the M1A2 SEP Version 2. We're looking at a SEP Version 3, which provides even greater capabilities. I think the focus on the Soldier is correct because we have all of this technology in our Armor platforms

where it's easiest to carry and manipulate. But, in the Infantry Brigade Combat Team, we have a lot more work to enable the network within the individual warfighter.

I know we are working to give individual Soldiers some of the firepower formerly available only from Armor or crew-served weapons, but there will always be a need for Armor. Over the past 13-plus years, we've become very good at counter-insurgency operations, but doctrine says we must also conduct unified land operations. We need to remain proficient as an Army with combined-arms maneuver–going out and fighting near-peer competitors with tanks, Bradleys and Artillery. We cannot assume that our next war will be fought the same way as the last one.

Army Technology: Why is there a need to keep increasing lethality?

Chandler: Our Army is going to draw down, which means the number of Soldiers we can put on the ground at any given time will also decrease. That's why technology and lethality must deliver overmatch against our adversaries. Science and technology can help deliver that decisive edge. We can do a lot with the power of the Soldier when it is accurately matched to technology that provides the outcome we want to achieve.

In addition to lethality, we also need to increase our precision. We can see the results of indiscriminant use of weapons and how that can turn the tide of public sentiment, both in a host nation and at home. We have made great strides in precision technologically, but the most precise weapon we have on the battlefield is the American Soldier. It's the person who makes the final decision to shoot or not to shoot. Combining our Soldier awareness and the technology that is available, we will be even more accurate and more lethal on the battlefield.

An example of that type of emerging capability is the developmental Hand Held Precision Targeting Device, a targeting system that will allow Soldiers to engage targets with precision munitions and provide digital connectivity to related units. This capability from PEO Soldier is being tested now at White Sands Missile Range, N.M.

Top: *Sgt. Maj. of the Army Raymond F. Chandler III talks to Soldiers at an observation post at Forward Operating Base Masum Ghar in Kandahar Province, Afghanistan, April 16, 2014. (U.S. Army photo by Cpl. Alex Flynn)*
Above: *Sgt. Maj. of the Army Raymond F. Chandler III visits with Pvt. Caleb McVay and Sgt. Brian Holt, both infantryman assigned to E Company, 16th Brigade Engineer Battalion, 1st Brigade Combat Team, 1st Armored Division, while conducting training June 4, 2014, at Fort Bliss, Texas. (U.S. Army photo by Sgt. Brandon A. Bednarek)*

Army Technology: How will Soldiers adapt to the coming improvements?

Chandler: When it comes to being agile and adaptive, our Soldiers' preeminence is unquestioned around the world. We've got to solidify the gains we've made over the past 13 years and look for ways to empower our most junior Soldiers to continue to be critical thinkers who understand the network and its ability to provide rapid and timely information.

For example, technological advances will enable extended range with precise and affordable weapons. Experts predict an individual Soldier of the future armed with a 40mm grenade may have the same lethal effects as 155mm artillery. But, as we add these additional technologies to every career field, I think our future challenges in this area will be our ability to recruit qualified candidates who meet both the educational and physical

demands and the moral and ethical capabilities to understand and employ these more advanced tools. If our potential recruitment population continues to shrink and the propensity to serve decreases, we must work with communities to ensure we are able to recruit young people who can meet the demands of the Army and feel comfortable with the technology and the lethality it represents.

Army Technology: How does training ensure that Soldiers understand new equipment, tactics, techniques and procedures?

Chandler: Training for time immemorial has provided Soldiers with the abilities to rehearse, exploit and learn as they become more familiar with the device or the weapon. I go back to my earlier experiences as a tanker for an example and what training did for me and my unit. When we started, we had immature capabilities. We could operate the vehicle and employ it on limited scale, but over time we became experts with the system and were able to harness all of its capabilities to project power when needed. We had to rehearse and train…experiment and try new things. As we move forward, we need to focus on training like this as we push the technological envelope to become immersed in the technological platforms of the system.

Even if we go through some tough fiscal times for training over the next few years, we know that the squad is the building block for the Army. If we can sustain and improve squad-level proficiency, not only as individual, but also members of a team, and if we use the technology to its maximum ability at the squad level, when it's time to surge or when we do get added dollars, we'll be better prepared to build platoons and companies and battalions and brigades. We'll be able to accelerate to the highest levels of readiness that much easier. That is the key.

However, when I arrived at my first duty station in Germany, the key to my successful training and understanding of the lethality of my equipment was not a manual, a training film or a beefed-up budget. It was my NCO. He was a Vietnam-era Soldier who had real-world experience, and he took the time to share that information with me and the other Soldiers he led. To this day, I credit him for making me a better Soldier and eventually a better leader. Every NCO in our Army today needs to do the same. If that doesn't happen, then the investments in technology and our potential lethal overmatch will be for naught.

Army Technology: Do you think there's a better way, or a greater need for Soldiers to get their technology feedback and requirements back to the researchers?

Chandler: It's very important to get hands-on Soldier feedback from those who use the equipment. It's crucial to its development and then fielding it to the force. Many of the things we did with the Future Combat System program within Brigade Modernization Command through NIE [Network Integration Evaluation] has really helped us get it to the Soldiers and then the feedback loop to the developers so we can move forward. It's crucial that we do this in the future.

The examples of our successes with Program Executive Offices and the ability of our educational system to overcome an evolving enemy and its tactics underscore the importance of that feedback from the Soldiers on the frontline. It literally saved lives and helped us be more capable.

Army Technology: What do you want Army researchers to know?

Chandler: First of all, Soldiers appreciate the kit that they have gotten over the past 12-13 years. There may have been some things that didn't meet the researchers' and the developers' idea of what was going to be successful, but by and large, what Soldiers have been given has been first class. More importantly, it has saved lives, and that needs to be recognized. Also, the further collaboration between Soldiers and other users with researchers and programs is important and should be sustained as far as we can into the future, perhaps in new ways that capitalize on the evolving paradigms of teamwork and development, such as STEM-based research communities.

Army Technology: How optimistic are you about building the Army of 2025 and beyond?

Chandler: Obviously there are some things that are not going to be in the Army's control, especially from a budgetary perspective and how that affects programs. But, I am confident we are going to do the best that we can with the resources that we have been given, in collaboration with our Soldiers, to get to where the Chief of Staff has said is our standard in 2025. I believe working with industry and recognizing the challenges we face will mitigate an uncertain budgetary future. Anything that is going to help a Soldier survive on the battlefield and accomplish their mission is what I am all about, so I am really looking forward to what the Army of 2025 looks like. ■

Investing in the Army's Future

The M142 High Mobility Artillery Rocket System, or HIMARS, fires a missile downrange. (U.S. Army photo)

BY DAVID MCNALLY, RDECOM PUBLIC AFFAIRS

The U.S. Army vision for lethality science and technology investment is to enable overmatch in weapon systems for both offensive and defensive capabilities.

Army Chief of Staff Gen. Raymond Odierno said attaining overmatch is critical to the Army of 2025.

"The Army has global responsibilities that require large technological advantages to prevail decisively in combat—'technological overmatch,'" Odierno wrote for the Army's official blog in 2012. "Just as airmen and sailors seek supremacy in the air and on the seas, Soldiers must dominate their enemies on land. Modernizing, especially as end strength is reduced, is the key to ensuring that the Army's dominance continues."

To achieve that supremacy, Army researchers aggressively pursue technological overmatch.

"In lethality, overmatch means we can defeat the threat to maintain an advantage," said Keith Jadus, acting director of the lethality portfolio for the Office of the Deputy Assistant Secretary of the Army for Research and Technology. "That means we have an advantage in every sense of the word. Overmatch is much bigger than lethality. We need to be able to see farther, reach farther and to ensure that our forces are protected outside the range and influence of the enemy."

Jadus said the goal of the lethality portfolio is to create an unfair fight.

"Part of my strategy in lethality S&T is that we maintain overmatch," he said. "It's absolutely true that lethality is part of creating an unfair fight, but we should never forget all the other pieces of that fight."

As researchers seek new offensive capabilities for long-range fires and small arms, they are also considering the Army's requirements for defensive postures such as air and missile defense.

"For air defense and missile defense, we're looking at kinetic weapons systems, such as missiles and gun systems, and non-kinetic weapons, such as high-energy lasers. These systems will be used to defeat rockets, artillery, mortars, unmanned aircraft and cruise missiles and also high-energy lasers as a directed energy solution," Jadus said.

"Lethality is more than just offensive lethality," Jadus said. "It is the ability to provide protection. Lethality is what protects our Soldiers. It is the capability to reach farther than our adversary and the ability for Soldiers to hold their ground, protect their ground and move forward.

The Lethality Portfolio represents S&T investments at the Armament Research Development and Engineering Center at Picatinny Arsenal, N.J.; the Aviation and Missile Research Development and Engineering Center and Space and Missile Defense Command at Redstone Arsenal, Ala.; and the Army Research Laboratory at Aberdeen, Proving Ground, Md.

AFFORDABILITY

Jadus manages an annual investment portfolio of nearly $250 million with wide-reaching implications for the Army of the future.

"The Army has to deliver affordable weapons systems because of the large number of systems it buys," Jadus said. "With the budget environment we are in, we have to focus our technologies on how we can bring additional capability while maintaining affordability."

EXTENDED RANGE

Army leadership wants to increase the range of its weapons systems. Across the spectrum of weapons systems, the Army needs to be able to engage ground targets—even greater than 300 kilometers offensive range. Army S&T is working on long-range fires to extend the range of rockets to address this challenge, and significantly increase the range of cannon artillery. The Army is also working to extend the reach of Soldier weapons, including individual weapons, mortars and close combat missiles.

PRECISION

"We need to be able to maintain precision," Jadus said. "We brought precision to our field artillery capability, and we've had precision in our rockets. We are trying to bring affordable precision to everything including small arms, 40mm grenades and mortars."

The Army uses GPS to great effect; however, planners see a need to provide precision even if GPS is denied.

"If we utilize GPS for guidance on a missile or artillery shell, we have to make that sure if somebody shuts down our GPS, we can still deliver the precision we promised," he said. "Technology investments today are focused on mitigating this risk."

SCALABLE EFFECTS

The Army also seeks a scalable range of effects, both lethal and non-lethal, Jadus said.

"Think of warhead effects that are able to be increased or decreased," he said. "We envision the capability to decrease lethality to reduce collateral damage, or increase lethality tailored to the targets. Traditionally we have focused a lot of our warhead technology on hard vehicle targets, but we need to be able to defeat a range of targets such as light vehicles, buildings and bunkers. We also need non-lethal solutions for our maneuver forces to operate in areas with non-combatants"

DISRUPTIVE ENERGETICS

Researchers and engineers have been manipulating an energy density curve for energetic materials for decades.

"Advancements have been incremental—5 or 10 percent here and there for a long time," Jadus

said. "But Army researchers are rethinking all the physics. They're going to the molecular level and discovering how we can put a lot of energy in a molecule and then find out how we can release that energy and look at something that would give us an increase of an order of magnitude or more in our energetic density."

What this can do for the Army is huge, he said. With new material science advances, researchers foresee a 40mm grenade that a Soldier fires from a rifle to deliver dramatic effects.

"You can really change the dynamic of what that Soldier is able to do," Jadus said. "It may mean a 40mm grenade with 155mm artillery effects. We may not get there, but it is certainly where this can take us. It can also radically increase the range of our weapons"

It's all in the name, he said. Disruptive goes beyond leap-ahead technologies.

"When we start getting these capabilities out there I think it's going to be disruptive," Jadus said. "We're going to have to look at how we engage in warfare. Advanced capability such as this warrants a holistic review of Army tactics, techniques and procedures. A battlefield where an individual Soldier possesses artillery lethality within a grenade-sized munition is a much different battlefield."

DIRECTED ENERGY

Researchers are also looking to one solution to counter the threat of rockets, artillery, mortars and missiles, and unmanned aerial vehicles with directed energy.

"Directed energy applications are considered game-changing technologies by the Army," said Richard De Fatta, director of the Emerging Technology Directorate within the Technical Center of the U.S. Army Space and Missile Defense Command and Army Forces Strategic Command. "When fielded, they will provide cost and operationally effective alternatives to conventional missiles, guns, and similar systems. A directed energy 'bullet' is generated almost entirely by electrical energy and does not require resupply except fuel to generate electricity."

With high-energy lasers, Jadus said there is still a lot to work out.

"We recently had some impressive demonstrations using a commercial laser and supporting beam control, power, and thermal subsystems all integrated onto a mobile military truck, yet we still need to further mature the technology," he said. "Our laser programs are achieving promising results in the laboratory, and we are developing support subsystems to enable long run-times at these laser's higher power levels."

NON-LETHAL OPTIONS

The Army is also looking at high-powered microwave and high-powered radio frequency technology to defeat electronics and other capabilities and help to disrupt other targets, such as the improvised explosive device threat.

"We're looking at this as a non-lethal weapon," Jadus said. "We can use a high-powered microwave to put energy on a person and force them to move out of the way. I've talked to Soldiers who have been demonstration subjects on this project. When subjected to the high-power energy beam, the demonstration subjects become so uncomfortable that they move away from the source. We are leveraging work done by the Joint Non-Lethal Weapons Directorate led by the Marine Corps and the Air Force on this technology."

Jadus said it will be interesting to see how the Army uses this capability.

"Some people call it a front bumper for our combat vehicle fleet. We can mount this on the front of a vehicle, so that if a crowd starts to come toward the vehicle, we can politely move them out of the way by putting a little bit of energy on them," he said. "It also helps us determine intent. If somebody is not pointing a gun at us, we can use a non-lethal device to disperse them. If they respond aggressively we can escalate to a lethal interaction, but it gives us the option not to have to."

FUTURE CHALLENGES

"I think a lot of technology that is advancing in the commercial world is of a lot of value to us," Jadus said. "We spend a lot of time looking at those technologies and then figuring out if we can use them in the military environment."

A challenge to developers is the gun-launch environment. As a gun-launched projectile exits the tube it may experience 20,000 or 30,000 Gs of force.

"There are not a lot of systems that encounter that shock," Jadus said. "We're talking tens of thousands of G forces exerted on electronics chips. We have to figure out how to make sure our chips are sufficiently hardened to weather that environment and remain viable. Those chips are essential to the accuracy of those systems because we have a very low tolerance for an error in the guidance system in a weapon. Honestly the difference is life and death."

Because the stakes are high, S&T investments are critical, Jadus said.

"We have the unique opportunity to explore and look at how we solve problems a little bit differently and with more innovation," he said. "We can shape the future. We can go try things. I think the environment we're in now is one of collaboration. We have frequent dialogs with our user representatives and our program executive office partners. We also work with them to develop long-range plans."

The Army also actively collaborates with industry and foreign partners to better understand what they have available.

"I believe in order for Army S&T to be truly innovative and deliver revolutionary capability to our warfighters, we need to expand our search beyond our traditional labs," Jadus said. "Taking the best industry, academia and our research partners have to offer, only then can we successfully increase our overmatch."

In recent years, the Army completed an internal process review on how it does long-range investment planning.

"This has been a windfall for S&T because now we know where the Army wants to go in the future," Jadus said. "Now we have a really good process to vet the future years' requirements and what associated technologies we need to develop. Does the Army want a new tank gun in the future or a new artillery system? The good news is we develop broadbased technology that applies to more than just one system. S&T is critical for the future as it informs the Army of the possible."

Jadus said there are many good S&T programs ongoing that will pay future dividends in terms of Army capabilities.

"If we don't prove it in S&T, and we don't deliver an affordable solution, when the program of record comes along it costs more to learn those lessons there," he said. "We play a critical role because we're helping to shape the path to the future. I think we're in a position to make a big difference. We have the talent to pull this off and that's exciting. I'm extremely optimistic. I think we're going to see a lot of new capabilities coming down the road. We are pushing forward to modernize the force. We have put an unthinkable capability in weapon systems that a Soldier can take onto the battlefield, but we still have a lot of work to do. We've gotten more precision and range, but everything we do is challenged. For every advancement through S&T lethality, an adversary is working on a way to defeat or marginalize it. That is why S&T in this area is really a big priority." ■

DISRUPTIVE TECHNOLOGY

How the Army Research Laboratory will change the future

BY MICHAEL ZOLTOSKI, ARL

Scientists are unlocking the mysteries of power, energy and lethality in the search for new materials and technologies. The U.S. Army Research Laboratory conducts fundamental research, which endeavors to provide revolutionary capabilities to the Army of 2025 and beyond.

In the science of lethality and protection, we face challenges as we look into the future and wonder what it will be like. We make predictions that guide the research of the underlying science that will have a significant impact 20 to 30 years into the future.

Our mantra is "assured delivery, overwhelming effects." Our research focuses on ballistic science and builds upon ARL's legacy as the world's foremost expert in interior, exterior and terminal ballistics.

We rely on sensor and targeting information from other sources as we focus our investigations on weapon launch, flight and target defeat. We further break down our programs into three technical areas:

- low-cost hyper-accurate weapons
- disruptive energetic and propulsion science
- lethal and scalable effects

We also have smaller efforts in the areas of electric fires, directed energy and Soldier lethality.

LOW-COST, HYPER-ACCURATE WEAPONS

In the future, we see every weapon system as being precise with a grand challenge of hitting moving targets at extended ranges without the use of terminal guidance. We aim to make these systems affordable by relaxing overly stringent constraints placed on the flight actuation and the guidance, and navigation and control technologies. We will accomplish this goal by conducting research in the areas of flight sciences and estimation and control theory.

Since we're looking far out onto the horizon, we must also consider how we will operate in what I would call a countered-environment, where traditional technologies like GPS are denied. This may happen because the enemy jams or attacks the weapon's electronics. For example, if GPS is jammed or denied, we can fall back to a different constellation of navigational sensors, which use advanced algorithms and mathematical solutions to guide the weapon to the target. The challenge we face is that some of these advanced algorithms cannot yet be processed in real-time on a chip that meets the size of smaller projectiles.

One nascent research area is image-based navigation at different bands with compressive sensing. This is where we use emerging sensing and blob detection techniques to locate threats, either identified before, at, or after weapon launch.

After threat detection, we must navigate and maneuver the weapon, further complicated by the fact that weapons fly at different mach numbers and may or may not be spinning. We have expanded our research into omnisonics (sub-, trans-, super- and hyper-sonic) as well as morphing airframes, which can change shape depending on what regime it is operating, and thus offer the potential to extend our range by more than 300 percent with unprecedented maneuverability.

While we want to put precision in every weapon, it most likely will be too costly for the Army to field weapons with pinpoint accuracy in large numbers. One of our more far-reaching concepts is called parent-child. In this concept, one weapon is designated as the parent and the other ones are called the children, which have a lower cost than the parent. The parent flies out and collects target information in real-time and then communicates and syncs this information with its children. The weapons then swarm and attack the threats identified by the parent weapon, providing overwhelming lethality when compared to current use of weapons on the battlefield.

Initial modeling shows that we could double or triple our current lethality using this approach.

DISRUPTIVE ENERGETICS AND PROPULSION SCIENCE

When combined with our other research areas, disruptive energetics and propulsion science have the potential to bring about revolutionary advances to the way we fight. We have known for several years that the performance of current energetic materials, which are based solely on carbon, hydrogen,

Fact Sheet: Extreme Accuracy Tasked Ordnance

For military snipers, acquiring moving targets in unfavorable conditions, such as high winds and dusty terrain commonly found in Afghanistan, is extremely challenging with current technology. It is critical that snipers be able to engage targets faster and with better accuracy, since any shot that doesn't hit a target also risks the safety of troops by indicating their presence and potentially exposing their location.

The Extreme Accuracy Tasked Ordnance system seeks to improve sniper effectiveness and enhance troop safety by allowing greater shooter standoff range and reduction in target engagement timelines. The objective of the EXACTO program is to revolutionize rifle accuracy and range by developing the first ever guided small-caliber bullet. The EXACTO 50-caliber round and optical sighting technology expects to greatly extend the day and nighttime range over current state-of-the-art sniper systems. The system combines a maneuverable bullet and a real-time guidance system to track and deliver the projectile to the target, allowing the bullet to change path during flight to compensate for any unexpected factors that may drive it off course.

Technology development in Phase II included the design, integration and demonstration of aero-actuation controls, power sources, optical guidance systems, and sensors. The program's next phase includes a system-level live-fire test and technology refinement to enhance and improve performance.

The Defense Advanced Research Projects Agency, or DARPA, conducted its first successful live-fire tests of the Extreme Accuracy Tasked Ordnance program April 21, 2014, demonstrating in-flight guidance of .50-caliber bullets. A video posted to Armed with Science, the U.S. Defense Department official blog, shows EXACTO rounds maneuvering in flight to hit targets offset from where the weapon is aimed.

According to DARPA, the EXACTO program is developing new approaches and advanced capabilities to improve the range and accuracy of sniper systems beyond the current state of the art, officials said. The system combines a maneuverable bullet and a real-time guidance system to track and deliver the projectile to the target, allowing the bullet to change path during flight to compensate for any unexpected factors that may drive it off course.

The EXACTO .50-caliber round and optical sighting technology may dramatically extend the day and night range over current state-of-the-art sniper systems.

EXACTO is being developed by Teledyne Scientific and Imaging with funding by DARPA.

Watch the video: http://science.dodlive.mil/2014/07/24/ [Source: DARPA]

nitrogen and oxygen chemistry, has reached a plateau. As such, several new research endeavors focused on higher density carbon-, hydrogen-, nitrogen- and oxygen-based energetic molecules and novel classes of materials, such as extended solids, were begun at ARL.

These new molecules and materials have the potential to increase energy by up to 30 percent or more, thus resulting in new weapon platforms, which have an order of magnitude more power relative to those using current propellants and explosives.

Before synthesizing higher density novel energetic materials, we use a complex suite of reactive multiscale materials modeling codes, developed using Army mission and high-performance computing resources, to computationally assess the potential performance and vulnerability characteristics of candidate molecules. These codes provide insight into the sensitivity and eventual performance and allow us to screen many different molecules before synthesis, thereby increasing number of molecules that we can investigate while reducing developmental time.

Unlike conventional energetics that are synthesized via traditional bench-top organic synthesis, the new extended solid class of materials, takes advantage of ultra-high pressure, which allows one to increase the energy stored between two atoms through manipulation of the bonding structure.

At our new state-of-the-art laboratory, we start our synthesis with a gas and then through a combination of high-pressure and temperature the gaseous material is converted into a solid with a highly strained network. In many cases, when the pressure is released the material simply converts back to a gas without any significant energy release. However, our computational models revealed several techniques for the stabilization of the highly strained solid, thus preventing the transformation back to the gaseous material. Using these insights, we were recently successful in experimentally recovering an extended solid from its high pressure synthesis conditions, which represents a significant breakthrough and a world's first. We are in the process of producing additional material so we can characterize several of its energetic characteristics in small scale experimental tests. Additional experimental efforts are also underway to develop techniques for larger scale production.

> "A disruptive technology is one that displaces an established technology and shakes up the existing methods or a groundbreaking product that creates a completely new method."

Michael Zoltoski leads lethality research at the Weapons and Materials Research Directorate within the U.S. Army Research Laboratory. (U.S. Army photo by Tom Faulkner)

LETHAL AND SCALABLE EFFECTS

Our final core research area studies the behavior and effects of a projectile when it hits its target. Right now, we focus not only on delivering the right amount of energy to the target but also on delivering that energy more precisely. At the same time, we are studying methods to service multiple threats with a single configurable penetrator that will be effective against armored vehicles, building, bunkers and personnel. Here we rely on the kinetic energy of the penetrator to destroy the varying target.

Another developing concept redistributes the energy on target to make a more effective use of it. Traditionally, if we look at the lethality of a single weapon, we waste a lot of energy because it is concentrated around the impact point and at further distances from the target, there is very little effect. This redistribution, delivered by a parent-child swarms approach, will be a significantly more effective use of the energy against a target.

CONCLUSION

We are not alone in our pursuit of overwhelming lethality as we partner and collaborate with the other RDECOM centers, Department of Defense, Department of Energy, universities and industries research laboratories, as well as defense research organizations from other countries.

We use communities of interests and practices, technology project agreements, cooperative research agreements and data exchange agreements as the mechanisms for these collaborations. This strategy guarantees information sharing that will be vital in reaching our joint goals of being able to reach farther and more effectively conduct joint operational missions.

There will be other emerging technologies in the Army of 2025 and beyond, like directed energy and electric fires. Directed energy will become more important as it transitions from its current state as a strategic asset with a large footprint due to size to generate, condition, store and deliver power to a tactical asset as the current power and energy footprint for directed energy weapons shrink in size.

We will shortly see high-powered microwaves or lasers on the battlefield accomplishing some of the missions of more traditional weapons for a simple reason: DE provides the opportunity to allow the Soldier of tomorrow to possess an infinite magazine. These weapons will not need ammunition resupply. As long as there is electric power, Soldiers will have an unlimited supply of firepower.

There is still a myriad of challenges to completely fulfill the promise of this technology. As researchers develop solutions for power, energy and thermal management issues, directed energy when combined with ballistic weapons will wield unprecedented lethal effects to accomplish the mission in a decisive manner. ■

Editor's note: Michael Zoltoski leads the Lethality Division of the Weapons and Materials Research Directorate within the U.S. Army Research Laboratory at Aberdeen Proving Ground, Md. He has published extensively at the classified level and has presented at both national and international conferences. Zoltoski earned a bachelor of science in civil engineering from Bucknell University and a master of science in mechanical engineering from Johns Hopkins University.

Future Fires

Creating specific lethal or nonlethal effects on a target

BY DAVID MCNALLY, RDECOM PUBLIC AFFAIRS

An M109A7 Paladin Integrated Management Howitzer fires rounds during a test at Yuma Proving Ground, Ariz. (U.S. Army photo by David Schacher)

Army leaders are looking to the future force and seeking to be revolutionary in their thinking about integrating technology, according to current guidance from Army Chief of Staff Gen. Raymond Odierno.

Department of Defense doctrine describes fires as the use of weapons systems "to create a specific lethal or nonlethal effect on a target. All fires are normally synchronized and integrated to achieve synergistic results." – Joint Publication 3-09

Army researchers are exploring technology solutions to enable improved lethality and fires. Fire support includes mortars, field artillery, air defense artillery, naval and air-delivered weapons. Successful fire support destroys, neutralizes and suppresses enemy weapons, enemy formations or facilities, and fires.

> "The capacity for physical destruction is fundamental to all other military capabilities and is the most basic building block for military operations. Army leaders organize, equip, train, and employ their formations for unmatched lethality under a wide range of conditions. The capability for the lawful, discriminate, and expert application of lethal force builds the foundation for effective operations."
>
> – GEN. RAYMOND ODIERNO, 38TH CHIEF OF STAFF OF THE ARMY MARCHING ORDERS

MISSILE RESEARCH

At the Aviation and Missile Research, Development and Engineering Center at Redstone Arsenal, Ala., engineers work on programs to help improve fire support and build the Army of 2025 and beyond.

"The Single Warhead for Area and Point, or SWAP, is focused on developing a single warhead that can address both area and point targets," AMRDEC engineer Mike Turner said. "This is a critical technology needed to address the capability gap created by the cluster munition policy and is expected to transition to the Precision Fires Rockets and Missiles Project Office in fiscal year 2016."

Cluster munitions open in the air and scatter large numbers of explosive submunitions, or bomblets, over a wide area. The Department of Defense Cluster Munitions Policy, signed by then-Defense Secretary Robert Gates in 2008, requires that after 2018, the United States will no longer use cluster munitions that result in more than 1 percent unexploded ordnance.

"We are focusing our research on providing the Army with enhanced capabilities that will enable the fires formation to engage targets at extended ranges, under all conditions, while conducting unified land operations in order to destroy tactical to strategic targets and provide fires support for decentralized operations over wide areas," Turner said. "Our investment is critically important if the Army is to remain a viable entity in an anti-access/area denial environment with an organic capability, particularly in light of the cluster munitions policy."

AMRDEC engineers are also researching the Low Cost Tactical Extended Range Missile, which has a longer term focus to develop technologies that enable dramatic range extension and operation in degraded environments such as a GPS-denied environment.

"We will be developing advanced propulsion technologies that will extend the range well beyond 300 kilometers and novel and unique navigation technologies that will reduce dependence on GPS for precision effects," Turner said.

AMRDEC engineers have historically provided unique solutions to artillery missile requirements, he said.

"The need for increased accuracy led to development of the Guided Multiple Launch Rocket System, or GMLRS," Turner said. "The ability of GMLRS to deliver effects within meters is a huge advantage that has gained notoriety among maneuver commanders."

Army, U.S. Marine Corps and United Kingdom forces have fired more than 3,000 GMLRS unitary rounds in combat.

"It is the commander's weapon of choice, engaging time-sensitive targets while minimizing collateral damage and protecting innocent civilians," Turner said.

Advances in technologies are significant, Turner said, and will allow U.S. artillery to "dominate the future battlefield."

"With new efficiencies, we will double the operational effectiveness of existing fire units through increased lethality and range," Turner

said. "Enhanced lethality and accuracy creates operational overmatch. The same technology advances required to realize this capability have wide-sweeping implications to the rest of the fires portfolio."

Providing low-cost precision effects without GPS is a significant challenge, Turner said. AMRDEC is focused on lower cost options consistent with current operational tactics, techniques and procedures.

ARTILLERY ENHANCEMENTS

At the Armament Research, Development and Engineering Center at Picatinny Arsenal, N.J., engineers are working on the Extended Range Cannon Artillery science and technology program, which aims to regain lethality overmatch to the Army's 155mm cannon artillery brigades.

"The intent is to provide the maneuvering forces an enhanced capability on the battlefield that will increase lethality at greater stand-off range and thus improve survivability and effectiveness on the battlefield," ARDEC engineer Upendra Patel said. "The final solution will provide full-spectrum coverage of long-range precision fires to the warfighter. Cannon artillery has always played a significant role in all of the nation's conflicts, and the U.S. Army has continued to use 155mm cannon artillery since World War I."

Operation Enduring Freedom and Operation Iraqi Freedom relied heavily on cannon artillery to provide timely indirect fire support, while minimizing collateral damage. More than 550,000 cannon artillery rounds were called in to directly support units in contact while battling adversaries in harsh desert and mountainous terrains.

"Field artillery will play a larger role in future conflicts due to the new technologies currently being developed which will enable effective engagements of a variety of targets over a wide operational area," Patel said. "Our effort is focused on a holistic system approach of cannon artillery technologies to improve range and rate of fire while maintaining precision."

The program will also develop advancements in novel propulsion and rocket-assisted projectile technologies while maintaining the current Modular Artillery Charge System and legacy ammunition compatibility for a full extended range system solution, he said.

ARDEC engineers also face significant challenges because investments in individual technologies will not meet the current capability gaps alone, requiring concurrent investment in multiple technology areas to meet objective capabilities.

"The ERCA Program employs a systems-trades approach to develop complimentary technologies for an optimal upgrade solution to existing and objective 155mm artillery platforms," Patel said. "This approach ultimately offers more functionality and performance than an individual technology area.

"Balancing the relationships between lightweight armament, fire-control, munitions, propulsion, and precision technologies will provide lethality overmatch in GPS-denied environments while reducing cost and risk of investment in individual technologies," he said.

The existing and future fleets of artillery platforms are targeted for technology transition. Transition planning is under way with both the M109A7 self-propelled and M777A2 towed howitzer program offices.

"Affordability must always be a consideration," Patel said. "To that end, the ERCA program will develop technologies with full government intellectual property data rights for transition to artillery acquisition program managers, enabling better buying power. We are also employing advanced modeling and simulation tools and techniques to accelerate technology development cycles and reduce the number of design iterations," Patel said.

DESIGNING USER INTERFACES

While the research centers are working to extend fire support range and lethality, the U.S. Army Research Laboratory is exploring what it takes for Soldiers to operate systems, both cognitively and physically.

"Today's young Soldiers are largely computer savvy, but they are not without limitations," said Army researcher Charles L. Hernandez, Fires Center of Excellence Field Element, Fort Sill, Okla. "New systems should not be designed to be so complex as to result in suboptimal employment by the user."

Motor, recognition and cognition skills are taken into consideration when designing user interfaces.

"The focal point for employing most fire support system-of-systems is the user interface," Hernandez said. "From a handheld or laptop device that are employed by Soldiers performing sensing and targeting functions on the battlefield, the UI chain moves to a computer with the software and networked communications necessary to communicate digitally and perform tactical or technical fire direction computations to be transmitted to the firing platforms where the human-in-the-loop chain ends via a digital display on the delivery platform that provides the firing data necessary to employ the fires that have been requested."

Hernandez said the interface at all levels must be designed to provide critical target and targeting information that is accurate and in clear and understandable formats.

"The complexity of the UI component is then therefore addressed by the Human Factors Engineering domain," he said.

HFE explores the integration of human characteristics into system definition, design, development and evaluation to get the best human-machine performance under operational conditions.

"The emphasis is on full consideration being given to both human capabilities and limitations in the designs of computer-based visual and audio displays that are manifested in graphical user interfaces," Hernandez said. "For fire support-networked capabilities, the GUI need not be identical across the entire fires warfighting function, but at each of the critical roles and functions of fire control, fire direction and fire support coordination, the GUI must allow a more user-friendly interface and allow for system training that focuses on the tasks and functions that are required to be performed at each level."

The end result of this research is GUI information displays that are less cluttered with information and perform more reliably, he said.

COLLABORATION

Across the Army, Research, Development and Engineering Command scientists and engineers collaborate on common goals.

"We are working with the Fires Center of Excellence Fires Battle Labs and participating in their war games to provide input to the technology development process and inform them of the ERCA S&T program's battlefield effectiveness and we also work collaboratively with domestic industry partners to develop high strength steels, metal matrix composites, novel propulsion and advanced manufacturing processes," Patel said.

"We have very strong relationships with not only industry and the program executive office, but also the Training and Doctrine Command," Turner said. "All of the concepts and technologies being developed have been vetted through both the PEO and TRADOC communities. This is critical if we are to develop relevant and transitionable technologies to the warfighter." ■

PEO Missiles and Space

Q&A WITH BRIG. GEN. L. NEIL THURGOOD

Brig. Gen. L. Neil Thurgood is the Program Executive Officer for Missiles and Space at Redstone Arsenal, Ala. He is responsible for the development, production, fielding, and life cycle management of the Army's missile and space related systems. Thurgood enlisted in the Army in 1983 as a private first class. He received a commission in 1986 as a distinguished military graduate in Army Aviation from the Reserve Officers' Training Corps. He graduated from the University of Utah with a bachelor's degree in business management and communication. He holds a master's degree in systems management from the Naval Post-Graduate School, a master's degrees in strategic studies, a doctorate in strategic business and leadership and several professional certificates.

Army Technology: What is the rationale for increasing firepower and lethality?

Thurgood: The U.S. Army is undergoing a transformation. After a decade of war, Soldiers and equipment are returning to an environment of declining budgets, drawdowns and a shift in operational focus. The Army is facing difficult decisions regarding force structure and modernization divestment. Unfortunately, the threat continues to increase in complexity as we reset, modernize and transform. These challenges are addressed by the Chief of Staff of the Army's Force 2025 initiative. Force 2025 will prioritize those technologies that support a leaner, more expeditionary force that exceeds current capabilities, allowing for increased firepower and lethality. In this fiscally constrained environment, modernization decisions will be balanced with technology investments to ensure readiness through the transformation.

Army Technology: How do you see technology empowering Soldiers with greater lethality in the future?

Thurgood: PEO Missiles and Space develops, produces, fields and supports U.S. Army, Joint and Coalition missile systems for air and missile defense, direct and indirect fires and aviation platforms. Several of the weapon systems that we manage include Patriot, Javelin, TOW and Hellfire. There is no doubt that the technologies of our missile platforms will be improved through the development efforts of tomorrow. There are several key areas of critical technology development that will empower Soldiers with greater lethality.

Warhead and fuze integration must be developed further. We need single warheads that are advanced enough to be scalable on demand as the mission situation dictates. In the future, the warhead and fuze development must be combined for a single resultant that will provide flexibility while reducing the burden to the Soldier and increasing the effectiveness of the missile system.

Advanced navigation systems that will fuse the single or dual navigation systems of today must be pursued. We must be able to reach off-board the missile system and draw information from other navigation sources that can aid in longer distance engagements and develop more technologies to improve accurate targeting, especially in the end-game.

The development of propulsion energetics should be accelerated. As we reach out further in distance and trend to faster in speeds, we need to reduce the size and footprint of our propulsion systems. This can be done through material synthesis and burn rate enhancement. While we develop these technologies, weapons must remain compliant with insensitive munitions regulations in the ever-changing environment of missile applications.

Speed and amount of processing capacity must be increased. In this area, we should develop processing that will increase precision acquisition, especially at the "end game" of the missile engagement. We need to enhance our auto-tracking capabilities. Increased processing must be tied to the next generations of Seeker technology. If we are to combine our current platforms into a single integrated effort, where we can use any sensor

to see the threat and the best missile to engage the threat—we need increased ability to process data in real-time. It requires multi-mission platforms with enough processing power and speed to provide a "defense-in-depth" using networked air, ground, naval and space platforms. This will enhance the speed of decision, reduce the kill timeline and subsequently increase the overall probability of success.

Army Technology: How does the Army promote the lethality knowledge base across the Army?

Thurgood: The Army supports and conducts a number of forums that leverage promising capabilities that solve operational gaps and demonstrate improved lethality. The Network Integration Evaluation is a semiannual field exercise that allows for the integration and evaluation of network and non-network capabilities to influence training, doctrine and organization decisions. Black Dart is an annual exercise that facilitates Department of Defense, Inter-agency, Industry and Academia current and near-term technology demonstrations to support counter-unmanned aerial system defense. Nimble Fire, a series of Operator-in-the-Loop wargames conducted by the Joint Integrated Air and Missile Defense Organization at the Virtual Warfare Center in St. Louis, Mo., supports evaluation of developmental concepts, advanced threats, Joint doctrine and Integrated Air and Missile Defense. These are just a few examples of forums across the community that promote the knowledge base for lethality improvements. Joint exercises with allied partners serve to increase awareness for the coalition forces.

Army Technology: What do you want Army researchers to know?

Thurgood: As we move together, we must foster innovation and accelerate mature technology to enable future force capabilities while exploiting opportunities to rapidly transition technology to the current force. Together, we must have solid, viable plans which effectively synthesize missile science and technology efforts through timely, coordinated study and evaluation of both current and future systems and technologies. This will come in two major parts. First, we must invest in technologies that will allow us to modify our existing system in the near-term allowing us to maintain threat overmatch. Second, we must develop new technologies through revolutionary S&T that will begin a new era of platforms designed to counter emerging air and missile threats. While we develop our collective S&T efforts, we must determine early in the development process which technologies have promise and discard those that will pay no future dividend. And we should never forget that it is a Soldier in the field who is going to fire the weapon and a Soldier who is going to sustain and maintain the weapon. As we develop and transition new technologies, it should be with the goal to provide increased survivability to the Soldier. This will encompass improved accuracy, increased lethality and minimize complexity; all attributes that will ensure his or her safe return at the end of every mission.

Army Technology: Budgetary challenges may impact future operations. How optimistic are you about building the Army of 2025 and beyond?

Thurgood: The current fiscal environment is forcing many difficult decisions. As previously discussed, the Army will be challenged to reset our equipment after a decade of war and balance modernization efforts, while funding near-term and "leap-frog" technologies to transform the force. Force 2025 activities have applied an analytic approach to prioritizing candidate technologies. Each center of excellence has presented and defended their top technology candidates against criteria for efficiency, dominance and expeditionary. The application of an enduring analytic framework/methodology will equitably prioritize candidate technologies across the Army's portfolios and inform investment decisions to optimize resource allocations. I am confident that this approach will determine the appropriate way ahead to meet the needs of the total Army during this transformation. ■

Fact Sheet: Army Tactical Missile System

The Army Tactical Missile System, or ATACMS, is a family of long range, all-weather, guided missiles. The ATACMS provides commanders an operational fires capability for precision engagement of the enemy throughout the depth of the battlefield, beyond the range of currently fielded cannons and rockets. It delays, disrupts, neutralizes or destroys high-payoff targets such as combat maneuver units; surface-to-surface missile units; air defense units; command, control, communications sites; and helicopter forward area rearming and refueling points.

The ATACMS Block I (M39) is a semi-ballistic missile with a warhead that contains approximately 930 M74 Anti-Personnel/Anti-Materiel bomblets. Each launcher pod accommodates one missile. The missile will engage targets throughout the corps area of influence, and is designed to destroy tactical missile launchers, suppress air defense, counter C3 sites, and disrupt logistics.

ATACMS Block IA (M39A1) uses the guided missile control and propulsion systems of the ATACMS Block I missile. The Block IA warhead uses a majority of the Block I warhead components, except the payload of M74 APAM bomblets is reduced to extend its range. Block IA uses an improved version of the ATACMS Block I Missile Guidance Set to achieve the improved accuracy needed to meet the Block IA system requirements for mission accuracy. The IMGS uses an Embedded GPS Receiver to receive and process GPS satellite navigation signals and to integrate the GPS data into the inertial guidance scheme of the missile to improve navigational accuracy.

The ATACMS Quick Reaction Unitary delivers a single, 500-pound high explosive warhead to its target using GPS, and it engages point targets with minimal collateral damage at ranges comparable to the ATACMS Block IA.

The ATACMS 2000 reduces production costs for while delivering a single, 500-pound high explosive warhead to its target using GPS. It engages point targets with minimal collateral damage, at ranges comparable to the ATACMS Block IA. The M57 variant was used successfully in Operation Iraqi Freedom and Operation Enduring Freedom.

[Source: PEO MS]

ENHANCED GRENADE LETHALITY

On target even when enemy is concealed

BY ERIC KOWAL, ARDEC PUBLIC AFFAIRS

How does the warfighter launch a grenade at the enemy and ensure it hits the target, especially when the enemy is in what is known as defilade, or concealment, behind natural or artificial obstacles?

Steven Gilbert and a team of about 10 engineers within the Joint Service Small Arms Program are trying to solve that counter-defilade puzzle, which also doubles the grenade's lethality in the process.

Gilbert is a project officer with the Armament Research, Development and Engineering Center. The engineering team is in the final phase of a project known as Small Arms Grenade Munitions, or SAGM.

The goal is to provide warfighters with the capability of shooting a 40mm low-velocity grenade out of an M203 or M320 rifle-mounted grenade launcher—with the certainty that if their target is hiding under cover or behind an object, damage will still be inflicted.

In this case, according to Gilbert, the SAGM round more than doubles the lethality of the current 40mm grenade against targets in defilade.

The SAGM project began in 2011, and the solution it seeks is not expected to be in the hands of Project Manager Ammunition Systems until July 2015.

Two critical areas were identified in the request for the needed capability the SAGM project is pursuing. When the enemy is hiding, improper ranging and overshooting the target

is not uncommon for Soldiers, since it is hard to locate the exact enemy position.

The first phase of the project entailed making the fuze component smaller while maintaining the same functionality. Engineers have taken a standard M433 grenade round and developed the SAGM.

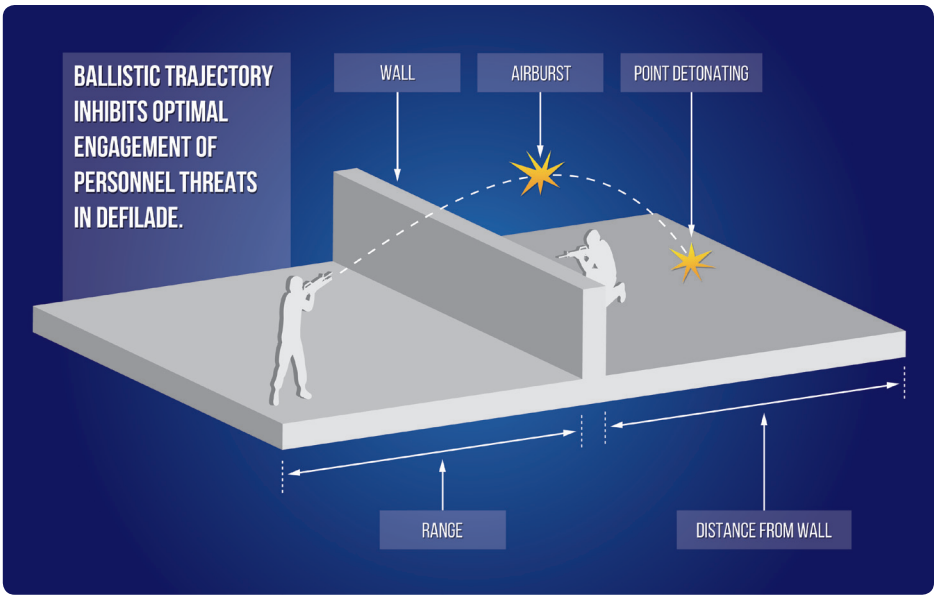
Gilbert described the round as being complementary to the XM25. The XM25 is a Counter Defilade Target Engagement System, which has an onboard laser system that determines the distance to the target.

"SAGM is complimentary to that; we are not competing against it," Gilbert explained. "The XM25 provides direct fire, SAGM is indirect."

The second phase was making the fuze smart by including sensors. The round detonates in what is called airburst. It will detonate over and past defilade obstacles that are detected by the sensor.

During this phase, engineers worked to integrate sensors and logic devices to scan and filter the environment and autonomously airburst the fuze in the ideal spot.

"Its intent is detonate over defilade obstacles and filter out stuff you don't want it to go off on or over," Gilbert said.



The third and current phase includes optimizing the fuze sensor that was integrated in phase two to improve ballistic accuracy, as well as integrating the new fuze with a live high-explosive warhead.

"Warfighters currently lack the ability to achieve desired accuracy and incapacitating effects against personnel targets in defilade at ranges from 51 to 500 meters," Gilbert added.

With this new capability, which is fully autonomous onboard smart sensors, much like a smartphone, the grenade can perform a task without being told to do so by the user. It is designed so that, when fired, it will recognize its surroundings and can detonate over an obstacle that might conceal the enemy.

The ballistic trajectory of legacy 40mm ammunition inhibits optimal engagement of personnel threats under cover. For these reasons, engineers are working to optimize ballistic trajectory and the overall accuracy and effectiveness of the grenade.

"There are three modes of firing," Gilbert said.

"Air burst after detecting defilade is the first. The default is point detonation or when it hits the target. Lastly there is a self-destruct feature which decreases collateral damage and reduces unexploded ordnance left on the battlefield or training ranges."

In addition to improved firepower, the SAGM round does not require the user to carry any extra gear or weapon accessories, advancing the goal of reducing Soldier load.

"We successfully demonstrated the Phase 2 sensor technology in November 2013," Gilbert said.

"This technology demonstration was conducted at Redstone Arsenal [Ala.] and it was shown that the sensor correctly detected defilade and air-bursted the round behind the defilade. This capability will inflict maximum lethality to any enemy personnel seeking cover behind defilade," he said. ■

Fact Sheet: XM25

The XM25 system is intended to compliment, not replace the M203/M320 systems. As part of the squad arsenal which includes the M203/M320 systems, the XM25 is being developed to address the capability gap of engaging personnel targets in defilade at ranges up to 500 meters.

Squad lethality capabilities are designed to be complementary and provide the small unit organic capabilities to engage multiple target sets at varying ranges under all conditions. The primary differences between the XM25 as compared to the M203/M320 deal with range, trajectory, fire control and warhead. The M203/M320 range against point targets is 150 meters and against area target is no greater than 350 meters. The XM25 can address point targets at 500 meters and area targets out to 700 meters.

The high muzzle velocity of the XM25's 25mm round provides a lower trajectory and extremely accurate targeting, maximizing the effects of fires on point targets, whereas the slower muzzle velocity and burst radius of 40mm round associated with the M203/M320 is more effective at engaging area targets.

The ground breaking advantage of the XM25 is the fire control system which includes an extremely accurate laser range finder, disturbed reticule (which provides the gunner the appropriate aim point on the target after taking into account range, environmentals, warhead velocity), and thermal imaging capabilities. The use of fire control systems, not only on the XM25 but on other weapons in the future, offer the next great leap ahead in terms of first-round lethality.

[Source: PEO Soldier]

SMALLEST GUIDED MISSILES

The Miniature Hit-to-Kill Interceptor was launched vertically and then conducted a series of maneuvers to demonstrate required performance while capturing data during tests conducted in May 2012 at White Sands Missile Range, N.M. (U.S. Army photos by Michael A. Smith and Louis A. Rosales)

Army developing small missile for big mission

BY RYAN KEITH, AMRDEC PUBLIC AFFAIRS

One of the world's smallest guided missiles has a big job to do.

The Miniature Hit-to-Kill, or MHTK, guided missile is about 27 inches long, 1.6 inches in diameter and weighs just 5 pounds. It has no warhead. Rather, as the name implies, it is designed to intercept and defeat rocket, artillery and mortar threats with kinetic energy during a direct hit.

The Aviation and Missile Research Engineering and Development Center is currently developing, fabricating and demonstrating MHTK as part of the Extended Area Protection and Survivability Integrated Demonstration, or EAPS ID. In June, the Army announced plans to complete development of MHTK, proposing a five-year follow-on contract with Lockheed Martin Missiles and Fire Control to complete missile development.

"The technologies being developed and integrated at AMRDEC are truly revolutionary," said Loretta Painter, AMRDEC EAPS program manager. "The level of miniaturization being achieved with respect to seekers, sensors, control actuation, and electronics packaging is remarkable. Missile components of this size and functionality have never been developed and flight demonstrated; until now."

MINIATURIZATION, MODIFICATIONS

EAPS ID is a science and technology program focused on developing and demonstrating critical technologies to counter rocket, artillery and mortar threats for potential transition to the Indirect Fire Protection Capability Increment 2 Intercept, or IFPC Inc2-I, Program of Record.

IFPC Inc2-I is a ground-based weapon system that will integrate into the existing Air and Missile Defense architecture. It is designed to acquire, track, engage and defeat UAS, cruise missiles, rockets, artillery and mortar projectiles in flight. Desired capabilities include 360 degree hemispherical protection, an increase in the defendable area, effective defeat of multiple threat types, a reduced logistics burden, and affordable life cycle cost.

Initially researchers developed three candidate interceptors under EAPS ID, but in 2013, the requirements changed to exclude additional fire control sensors in the battlefield which led to a system down select. The Army redirected MHTK efforts to incorporate the risk reduction miniature fully active RF seeker that the AMRDEC had been working on with applied research S&T funding.

"We have gone from a semi-active seeker configuration to an active seeker configuration to eliminate the need for a ground-based illuminator," Painter said.

The fully active RF variant of the MHTK missile self illuminates the target. Any ground-based or airborne sensor capable of tracking rockets, artillery, or mortar, commonly called RAM, threats can queue the MHTK guided missile. Once launched, and based on queuing, the missile flies autonomously to engage and defeat the threat.

While more expensive than the semi-active seeker, the fully active seeker provides greater precision needed for other potential target sets.

"Being able to hit a vulnerable part of the target as opposed to just hitting the target is a big advantage," Painter said. "The active seeker will allow us to have aim point selection, to be able to select the place on the target that we want to hit to maximize lethality."

Also in 2013 it was announced that all IFPC Inc2-I interceptors would share a common launcher, the Multi-Mission Launcher. In a separate effort managed by AMRDEC, the MML is being designed to fire a variety of missiles to meet IFPC Inc2-I requirements. The MML tubes allow for multiple missiles of different types to be loaded simultaneously.

MHTK is the smallest of the candidate interceptors to be integrated with the MML, and therefore promises the greatest load out. Load out, or the maximum number of missiles a launcher can hold, is a critical capability in combating saturation attacks, multiple simultaneous engagements with RAM threats. Four MHTK missiles will be integrated into each MML tube.

"If you had fifteen tubes, you would have a load out of sixty MHTK missiles. Or you could have some mix of larger missiles in some of the tubes, but it would still allow us to have a large loadout to meet the requirements in the CDD—the Capability Development Document," Painter said.

MATURITY

Under the EAPS ID program, MHTK components have been integrated and flight tested three times at White Sands Missile Range utilizing the semi-active RF seeker to provide proof of concept and lethality.

The first fully guided flight test of MHTK against a RAM target occurred in January 2014. While this flight test of MHTK was a very near miss, all the MHTK components with the exception of the seeker are considered to have achieved a technology readiness level of 6. These components include the control actuation system, inertial measurement unit, electronics, thermal battery, telemetry, airframe and rocket motor. The system is currently at technology readiness level 5.

Additional flights are scheduled through 2015, and will continue to use the semi-active RF seeker.

Assistant Secretary of the Army for Acquisition, Logistics and Technology Heidi Shyu inspects a Miniature Hit-to-Kill missile. (U.S. Army Photo by Merv Brokke)

Beginning in 2016, flight tests will use the fully active RF seeker.

In 2013, the Cruise Missile Defense Systems Project Office announced a block acquisition strategy for IFPC Inc2-I. Block 2 will address counter RAM capabilities.

ADDITIONAL APPLICATIONS

While the MHTK guided missile is currently being developed for the counter-RAM and counter-UAS missions using hit-to-kill lethality, this revolutionary miniature technology could be used as is or adapted to address other missions and requirements. For example, with the advancement of other miniature technologies such as semi active laser seekers and blast fragmenting warheads, this miniature technology could be adapted to a variety of air-to-air, air-to-ground, and ground-to-ground roles.

Lethality on a Beam of Light

U.S. Army Space and Missile Defense Command researchers explore high-energy lasers

BY CHARLES LAMAR, SMDC TECHNICAL CENTER

The High Energy Laser Mobile Demonstrator, or HEL MD, is the result of U.S. Army Space and Missile Defense Command research. (Photo by Eric Shindelbower)

High-energy laser research has been ongoing since the 1960s. But the Army is now getting to the point where demonstration systems are shooting down mortars and unmanned aerial vehicles with high-energy lasers.

"This is a future capability for our Army," said Keith Jadus, acting director of the lethality portfolio for the Office of the Deputy Assistant Secretary of the Army for Research and Technology. "When you deal with what we call disruptive technology, where the capability is so divergent from how we currently do business, we are required to consider more than just the lethal impacts. We must consider the doctrinal implications on how we fight in the future. Technology such as this creates opportunities to fight a different fight, and can impact the full spectrum of warfare."

With high-energy lasers, Jadus said there is still a lot to work out.

"We recently had some impressive demonstrations using a commercial laser and supporting beam control, power, and thermal subsystems all integrated onto a mobile military truck, yet we still need to further mature the technology," he said. "Our laser programs are achieving promising results in the laboratory, and we are developing support subsystems to enable long run-times at these laser's higher power levels."

As Army researchers validate the technology, officials remain optimistic about its potential.

The High Energy Laser Mobile Demonstrator, or HEL MD, is the culmination of the Army high-energy laser technology development and demonstration program, according to officials. It is a completely contained HEL weapon demonstrator mounted on an Army truck with a significant track record for engaging and destroying mortars.

The HEL MD will integrate will integrate, in the near future, a more advanced electric laser into its beam control system.

Lethality testing is a crucial component of the Army's High Energy Laser Program.

"Our goal is to have a demonstrator HEL weapon available in very near term", said Richard De Fatta, director of the Emerging Technology Directorate at the Army's Space and Missile Defense Command. "Our lethality team is responsible for acquiring the essential effectiveness data so that we can make the appropriate program decisions at that time."

HISTORY

In the summer of 2000, the Tactical High Energy Laser, or THEL, shot down its first artillery rocket and began a successful program that lasted several years ending with a kill success against rockets, artillery and mortar greater than 90 percent.

The U.S. Army Space and Missile Defense Command and the Israel Ministry of Defense jointly developed the THEL. Its ultimate destination was intended to be the northern border of Israel. Despite its technical success, officials decided against deployment. THEL relied on toxic chemicals for its operation, which affected system reliability, logistics, cost and safety. However, the program did not end. U.S. Army researchers continue to work on high-energy lasers, known as HELs.

Solid state lasers that relied strictly on electricity for power seemed to be the better solution, but they were not of the technical maturity needed for a weapon. The Joint High Power Solid State Laser, or JHPSSL, program was the answer to the technology shortfall. The JHPSSL program started as a joint effort with the High Energy

Laser-Joint Technology Office, the Army and the Air Force. The program achieved its primary objective in 2009 as Northrop Grumman demonstrated a solid-state laser world record power of more than 100 kilowatts for several minutes.

One challenge the research and development teams faced was that the lasers were not rugged enough for Army weapon systems.

The program objectives of JHPSSL were to demonstrate coherence and power. The resulting product of the JHPSSL program was a laboratory device not suitable for the difficult conditions that weapon systems encounter.

The Robust Electric Laser Initiative, or RELI, program addressed the problem.

"The RELI program significantly advanced solid state laser technologies", De Fatta said. "The Army is confident that RELI technology developments will result in fundamental capability advances for future laser weapon systems."

THE FUTURE

The products of this program were to be high-energy laser technologies with the size, weight and ruggedness suitable for development into high-energy laser weapons for multiservice applications.

The new electric lasers operate at much shorter wavelengths and lower powers than their predecessor chemical lasers. The shorter wavelength can result in smaller, more intense laser beams; however, atmospheric interactions and target effects can be substantially different at the shorter wavelength. The shorter wavelength and lower power shifts more performance burden to the beam control system.

The beam control system is the other high tech component of the HEL weapon. The beam control system must precisely point the HEL to the target. The target can be the size of a soft drink bottle and many kilometers away from the laser. The beam control system must point and maintain the beam on the target to a precision of less than a centimeter. In addition, the atmospheric turbulence over these long paths causes the beam to spread. The beam control system must correct for this spreading through the use of potentially complex adaptive optics.

It is the combined effect of the HEL and the beam control system that determines the overall lethality of the weapon. Army lethality scientists must estimate the performance of the beam control system and the HEL and then conduct tests that properly simulate this performance.

SOLID STATE LASER TESTBED

Recognizing the importance of measuring the lethality of HEL weapons, the Army established a facility dedicated to HEL lethality measurements. The Solid State Laser Testbed, or SSLT, is located at the High Energy Laser Systems Test Facility at White Sands Missile Range, N.M. It is a one-of-a-kind Department of Defense asset operated by the U.S. Army Space and Missile Defense Command that enables lethality scientists the capability to conduct both static and dynamic testing.

The SSLT currently consists of two HELs and a beam control system. To make the most effective use of resources, the primary HEL is the JHPSSL built by Northrop Grumman. It

Army's solid-state Laser testbed undergoes trials

BY JASON B. CUTSHAW, SMDC

The U.S. Army Space and Missile Defense Command has used a solid-state high-energy laser testbed to engage and destroy threat representative targets in tactical scenarios.

The Solid-State Laser Testbed, or SSLT, is part of an Army test designed to investigate military applications and validate the operational utility of high-energy lasers. Results from testing in April have confirmed that solid-state lasers can negate unmanned aircraft vehicles and rocket, artillery and mortar threats in flight.

"The Army-Northrop Grumman team put in a lot of work to complete these impressive demonstrations," said Richard P. De Fatta, director of theSMDC Emerging Technology Directorate. "We still have a lot of lethality and performance data to collect for model refinement, but the success of these demonstrations represent extremely important technical milestones. These demonstration results reduce overall program and technical risk while increasing confidence in the community that we can deliver this revolutionary capability to our Soldiers."

SSLT will be used to evaluate the capability of a high-energy solid-state laser to accomplish a variety of missions. Those results will be the basis for directing future development of solid-state lasers for use on the battlefield.

The SSLT is a high-energy laser, or HEL, system located at the High Energy Laser Systems Test Facility at White Sands Missile Range, N.M. The SSLT uses the technology from the Joint High Power Solid-State Laser, or JHPSSL, and the Pointer Tracker Subsystem Tactical High Energy Laser.

JHPSSL was built as a joint venture between SMDC and the Department of Defense High Energy Laser-Joint Technology Office, with support from the U.S. Air Force Research Laboratory. The laser was designed and built by Northrop Grumman Corporation at their Space Park facility in Redondo Beach, Calif., on an Army contract.

"The primary function of the SSLT is to collect lethality and beam propagation data needed by military planners to validate directed energy models to help determine the next steps for developing laser systems for the battlefield and, eventually, provide this revolutionary capability for our Soldiers," said Charles R. Lamar, SMDC Technical Center.

Lamar said high-energy lasers offer the potential to defeat a number of targets of military interest including rockets, artillery, mortars, unmanned aerial vehicles, UAV-mounted sensors and cruise missiles.

"HELs were modeled and performed well in a recent Army Analysis of Alternatives," said Lamar. "This AoA was the Integrated Force Protection Capability's second increment. AoA had as its goal the development of a capability to defeat RAM and UAVs. Not only were HEL weapons effective at engaging enemy threats but they were also projected to be cost effective.

"SSLT provides important weapon effectiveness information in support of HEL weapon system development with the ability to conduct HEL lethality and propagation experiments at weapons scale power level," he added. "These experiments include both static lethality experiments and dynamic tests where flying targets are engaged and defeated by the laser system."

For more than 30 years, the Army and other DOD organizations have developed and tested a variety of directed energy devices,

was refurbished and relocated to White Sands Missile Range. Officials said the challenge was to locate a laser designed for the laboratory to a relatively remote location in the desert. In addition, the beam control system is the same system built for the THEL program more than 10 years ago. Engineers refurbished and modified it to account for the different wavelength of the JHPSSL. For lethality testing, it is not necessary for the beam control system to operate at the full performance level of a modern tactical beam control system as long as the actual performance is properly characterized. The HEL and the beam control system were successfully integrated, and they have already provided a substantial amount of lethality data.

In static testing, the vulnerability of a target to laser irradiation is assessed in controlled conditions that include basic material, or coupon, testing as well as target testing. Dynamic testing is a more complicated and expensive test. In dynamic testing, the target is flown much like it would be in an actual wartime engagement. The system under test must acquire the target, track the target, point the laser to the target, and then fire the laser. Dynamic testing enables a combined performance measurement of the beam control system and the HEL. Due to the difficulty in measuring beam control performance on a rapidly moving target, static testing is a critical step in the process of making a total performance measurement.

The lethality testing process starts with the identification of the target. A geometric model of the target is created and, if the target is complicated, a failure modes and effects analysis, or FMEA, is accomplished to identify the most promising aimpoints. The FMEA is accomplished in concert with laser interaction physics models. Once these models are constructed, a beam control system model is constructed using the estimated performance parameters of the beam control system. The net result of these steps is a list of the most promising aimpoints that are then tested in a series of static tests. The static tests identify the highest priority aimpoints.

The engagement model is the final step before the dynamic test. It is an end-to-end simulation of an engagement. The actual engagement is typically constrained by the capabilities of the test range, in this case White Sands Missile Range. The engagement model uses the beam control system performance, the lethality data, and the target data to make estimates of the necessary dwell time on the target. The engagement model results are used to plan the details of the dynamic test. The predicted kill time and the actual results are then compared. If the results are within experimental error, then the vulnerability of the target has been verified.

For researchers, this is an ideal description of the process. In reality, one or more of these steps can often not be accomplished due to circumstances beyond the control of the test scientists. A target may be too expensive, a target may not be available, or the test budget may not support a large number of dynamic tests. These constraints put a premium on the use of verified and validated models. The scientists must identify these models early in the process and conduct the tests in the proper manner to provide the confidence needed to rely on these models when there is no test data available.

CONCLUSION

HEL weapons have captured considerable attention in recent years. Officials said the Army has a plan for development and potential deployment of a laser weapon in the not too distant future.

"This is a great time to be a part of this technology," De Fatta said." The Army is well positioned to take advantage of recent technology advances. We are excited about the opportunity to develop, test, and field these new weapon technologies for our warfighters."

Editor's note: Charles LaMar is a member of the Army Space and Missile Defense Command's

Technical Center assigned to the Directed Energy Division. Lamar is the program manager for the Army's Solid State Laser Testbed and has written more than 50 professional papers and publications in the field of high-energy lasers. ■

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including both chemical and solid state lasers. High-power chemical lasers, such as THEL, proved to be successful in testing against RAM, but the use of chemical fuels would cause a large logistical burden for the Warfighter.

In 2005, the Army decided to focus on all-electric SSLs to the lower -cost high-energy lasers as a path to the future, with the only consumable being diesel fuel for electric generators to power the lasers.

"UAVs are widely proliferated on the modern battlefield. Enemy UAVs, whether armed or equipped with sensors, represent a significant new threat to our deployed forces," Lamar said. "HELs offer the potential to be a cost effective means of providing our armed forces with a revolutionary capability to engage the enemy and save Soldiers' lives. The data developed by the SSLT will help determine if HELs are ready to achieve this potential."

This beam director was used for the Mobile Tactical High Energy Laser and has been reformatted to support the Solid State Laser Testbed Experiment at High Energy Laser Systems Test Facility at White Sands Missile Range, N.M. (U.S. Army photo)

Improved Mortars

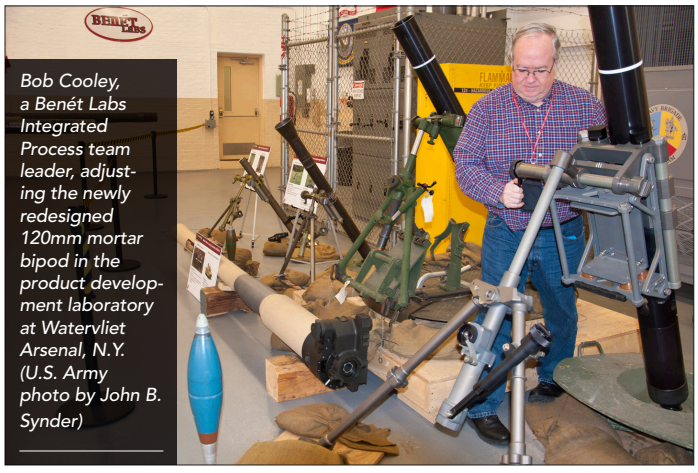
Redesign to help infantrymen become more lethal, safer

BY JOHN B. SNYDER, WATERVLIET ARSENAL PUBLIC AFFAIRS

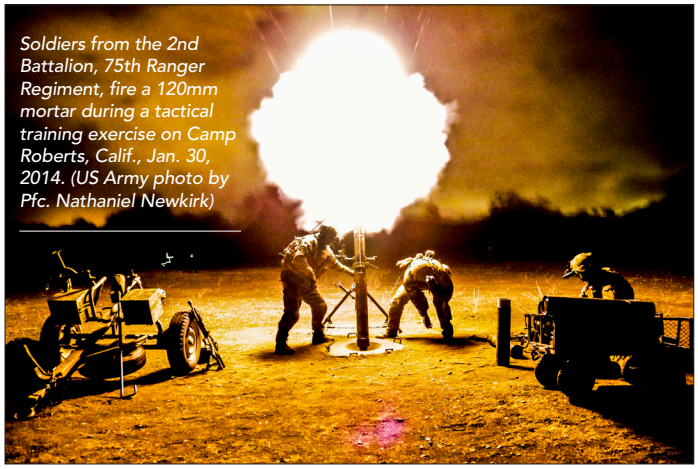
The U.S. Army has lightweight mortar systems, range and a significant amount of lethal and destructive fire to close-range combat. Why would anyone think about tweaking something that has already been proven very capable in training and in combat?

"It is all about our troops maintaining the competitive edge over potential adversaries," said Wayland Barber, chief of the Mortars and Recoilless Rifle Branch at Benét Laboratories at Watervliet Arsenal, N.Y. "Even without funding for new weapons research, Army scientists and engineers are always seeking opportunities to improve weapons systems that are in the field."

"No sooner than we field a new mortar system, our customers demand that we make it better in regards to extended range, increased lethality or capability, and reduced weight," Barber said. "This triggers the entire Army research community, from those who improve the lethality of ammunition to those who design the delivery system, to work on parallel and converging fields of science to achieve a common goal."



Bob Cooley, a Benét Labs Integrated Process team leader, adjusting the newly redesigned 120mm mortar bipod in the product development laboratory at Watervliet Arsenal, N.Y. (U.S. Army photo by John B. Synder)



Soldiers from the 2nd Battalion, 75th Ranger Regiment, fire a 120mm mortar during a tactical training exercise on Camp Roberts, Calif., Jan. 30, 2014. (US Army photo by Pfc. Nathaniel Newkirk)

Barber supervises 14 Army civilian engineers and technicians who not only design and build prototypes of future mortar and recoilless systems, they also design product improvements of what has already been fielded. Given today's fiscal challenges and lack of major orders for new weapon systems, improving what the U.S. military currently has fielded drives Barber and his team's near-term focus.

Some of the latest work at Benét Labs transcends all fielded mortar systems in the U.S. inventory, from 60mm to 81mm to 120mm mortars.

"The current 120mm mortar system has good range, is reliable, and the troops like it," said Bob Cooley, a Benét Labs Integrated Process team leader. "But as good as that system is, we have several product improvements that we are currently working that may improve Soldiers' safety, increase range by up to 25 percent, and reduce the system's weight by nearly 16 percent."

"One of the major upgrades to the 120mm system is with its bipod," Cooley said. "Our bipod redesign will improve the accuracy of the system because it moves the fire control system from the tube to the bipod."

According to Cooley, the fire control system, or FCS, is currently attached to the tube, which places a significant amount of stress and movement on the FCS during a fire mission. By moving the FCS to the bipod, there will be less force exerted on the system, which will improve accuracy.

Another design improvement for the 120mm mortar system includes a new baseplate that will provide more stability for extended range munitions, and save money. If the redesigned baseplate goes into full production, it will cost nearly 50 percent less than the current system. The qualification test was recently completed with the firing of 3,000 rounds without incident.

The final piece to the redesigned 120mm mortar system is an improved cannon tube. When extended range ammunition is developed, the tube must also be modified to withstand higher tube pressure, heat and muzzle velocity.

Benét Labs plans to conduct a full-quality testing of the redesigned 120mm mortar system in fiscal 2015, and Barber's team is also doing research and design work on the 60mm and the 81mm mortar systems.

Benét Labs, which is part of the Armaments Research, Development and Engineering Center, has a history of designing and fielding new weapon systems. Although Benét officially opened its doors as the Army's large caliber research and design facility in 1962, its weapons research at the Watervliet Arsenal dates back to the 1840s.

READY NOW

ATK is leveraging proven innovations that deliver precision capabilities and enhanced effects to conventional weapons systems.

Photo credit - U.S. Army

The XM395 precision mortar cartridge supported combat operations in Afghanistan.

Precision Mortars and Artillery – Combat Proven

By combining GPS guidance and directional control surfaces into a package that replaces standard fuzes, ATK's Precision Guidance Kit (PGK) approach for artillery and mortar munitions share a common design and maximize the U.S. Army's investment in guidance fuze technologies. This approach also creates economies of scale when production quantities are approved for delivery and fielding.

ATK and the U.S. Army's PEO Ammunition's Product Manager for Guided Precision Munitions and Mortar Systems transformed existing 120mm mortar cartridges into precision guided munitions to support operations in Afghanistan through the Army's Accelerated Precision Mortar Initiative (APMI). The resulting XM395 mortar cartridge put organic, precision engagement capability into the hands of the battlefield commander providing a quick response munition with at least 10-meter accuracy.

The XM395 design is based on ATK's PGK technology for 155mm artillery. Known simply as PGK, the artillery guidance fuze proved its ability to reliably deliver 30-meter accuracy or better in both training and combat operations in Afghanistan.

While the XM395 showed that it will reliably deliver 10-meter or better accuracy in combat through APMI, the next step in fully fielding a precision mortar across the Army is yet to come. However, APMI's success has helped shape the requirements for a future guided mortar program of record.

XM395 120mm Precision Mortar

Meanwhile, ATK will soon deliver the Precision Extended Range Munition (PERM) to the U.S. Marine Corps for demonstration tests (with objectives of 20-meter accuracy at ranges to 16 km and beyond) that will help the Marine Corps determine what technologies are currently available to support a precision capability for their 120mm rifled mortars.

Affordable Precision Mortars

ATK's guided solutions have proven themselves in combat and through exhaustive testing – having certified critical safety, reliability and performance characteristics. The completion of these verification tests, combined with the product process control plans leveraged through the continued success of PGK and PERM, make the XM395 a mature and affordable technology that will transition quickly to production.

Lethality Enhanced Ordnance – LEO

In addition to developments in munition guidance, ATK is designing and building next generation ordnance that will yield greater combat effectiveness while exceeding future safety and compliance requirements. Lethality Enhanced Ordnance, or LEO, is positioned as a drop-in replacement for current cluster munitions. Available today, LEO maximizes target effectiveness through enhancing the warhead capability of conventional mortar cartridges and artillery projectiles while also leaving no Unexploded Ordnance (UXO) on the battlefield. ATK's 60mm mortar has started production and ATK's Guided Multiple Launch Rocket System (GMLRS) Alternative Warhead is now qualified and will begin production in 2015.

These are just a few examples of how ATK is delivering next generation capabilities to the warfighter today.

Affordable. Combat proven. Ready now.

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Sgt. 1st Class Mark Minisi (left) and Sgt. 1st Class Christopher Holmes run through a simulation in the Simulated Weapon Environment Testbed, or SWeET at Picatinny Arsenal, N.J. (U.S. Army photo by Erin Usawicz)

Weapon Development

Sophisticated simulations help researchers improve weapons

BY ED LOPEZ AND CASSANDRA MAINIERO, PICATINNY ARSENAL PUBLIC AFFAIRS

As engineers design new weapons or modify existing ones, reducing time and money on development can be critical in providing Soldiers with improved weapons without undue delay.

A new sight may be planned for the M4 rifle, but how well does a prototype design work? Where would be the best place to mount it for the most accuracy and ease of use? Or new, nonlethal weapons may be needed, but will they perform as expected at different ranges?

Using a combination of artificial intelligence, cameras and computers loaded with ballistics data, engineers at Picatinny Arsenal, N.J., have developed a testing environment that can help to answer many critical questions about the performance of existing weapons and new ones planned.

"People are surprised how realistic our simulated environments look," said Keith Koehler, a mechanical engineer at the Weapons Technology Branch, part of the Weapons Software Engineering Center, Armament Research, Development and Engineering Center. "We had a few friends, who were deployed Soldiers, walk into the scenarios and you could tell to a degree that they lost themselves in the environment."

The Simulated Weapon Environment Testbed, or SWeET, can project custom interior and outdoor scenarios for weapons evaluation. It can also project any weather, location or time of day onto its five screens, allowing up to four users per screen.

While it can take a few weeks to program new environments into the software, gathering data is instantaneous. It records details such as target response, user response, reaction time, and target distance during each simulation.

SWeET works with unmodified weapons—only bolts and magazines are swapped. Compressed air or CO_2 is used to simulate recoil.

Weapons that can be currently tested in SWeET are the M4, M11, M9, M16, M249, M240 and weapon accessories. With five cameras and computers behind the screens that display simulated scenarios, and a sixth computer to control them all, researchers capture realistic projectile ballistics and travel and impact effects.

Other cameras, placed above the five screens that project a 300-degree view, can monitor a Soldier's movements and reactions during the various scenarios.

A major advantage of SWeET is it can capture vast amounts of data with prototypes of new weapons, the costs related to manufacturing multiple weapons during the development phase can be greatly reduced.

"Users can come here and test a weapon or the new ammunition before it is even made," said Clinton Fischer, a mechanical engineer, also with the Weapons Technology Branch. "In traditional development, they would have to first manufacture the weapon or the ammunition for it. Because there is no production line for it, it could be a thousand dollars a round," Fischer added. "Here, we just make it, shoot and get data."

Because SWeET projects virtual environments onto two-dimensional screens, Fischer and Koehler also note that scope (or depth) can sometimes be difficult to mimic.

In the future, Fischer and Koehler plan to add new simulated weapons to the test bed, such as the M2 heavy barrel machine gun and the Mk19 grenade machine gun.

"There are lots of simulators out there, but they're limited in their capability and each one is made to train a specific situation," Koehler said. "One may train how you work in a squad; another is how to train your weapon, or something else. There are simulators for research and development to get information, but they are also limited. With SWeET, we're trying to take all those types of simulations and combine them. I don't think there is anything out there yet that can test all these capabilities."

ARMY TESTS SAFER WARHEAD

Reducing the danger of unexploded ordnance

BY JOHN ANDREW HAMILTON, ATEC PUBLIC AFFAIRS

A guided rocket test conducted at White Sands Missile Range, N.M., April 3 saw the use of a new warhead designed to maintain military capabilities while reducing the danger of unexploded ordnance.

The new warhead being developed by the Precision Fires Rocket and Missile Systems program's Alternative Warhead Project is expected to replace the cluster munitions being phased out by the U.S. military.

Cluster munitions are designed to disperse a large number of small grenade-like bomblets over a large area. While highly effective against area targets, all the bomblets don't always explode and can remain on the battlefield for some time, posing a risk to civilians or servicemembers working in the area. This danger resulted in the United States banning the export of cluster munitions to allies and setting limits on their future use.

At the end of 2018 our inventory is no longer usable, and there are constraints on its use today," said Col. Gary Stephens, project manager for the Alternative Warheads Program. "The Guided Multiple Launch Rocket System, or GMLRS, alternative warhead is the materiel solution replacement to meet that still remaining requirement for an area weapon."

To replace cluster munitions, the Army is developing a large airburst fragmentation warhead. Mounting the warhead on a rocket compatible with the widely used GMLRS family of launchers, this new weapon can be accurately guided to a target area where it explodes about 30 feet above the ground, filling the air with hundreds of bullet-like penetrator projectiles. The result can cause considerable damage to a large area, but unlike cluster munitions, leaves behind only the solid metal penetrators and inert rocket fragments.

The test saw the use of the rockets in a truck-mounted launcher engage four target areas; the first three built to represent military targets like radar stations and command posts, with a fourth location vacant of any special target structures with the shot focusing on the warheads overall function and reliability.

"Our range operations, targets and the target area (personnel) really pulled this mission together under some really adverse conditions, particularly temperature and wind," said Jerry Tyree, director of WSMR's Materiel Test Directorate. "The guys that are out in the field operating that equipment are really key to making that happen."

This test, the fifth in a series of production qualification tests, is expected to allow the warhead to transition to developmental and operational testing so the system can be further refined and adjustments made to better accommodate Soldier needs.

"This is a milestone for the program, the Army, and even the nation in respect to the cluster munitions," Tyree said.

A High Mobility Artillery Rocket System fires a rocket equipped with an area effect warhead designed to replace cluster munitions in a test conducted April 3, 2014, at White Sands Missile Range, N.M. (U.S. Army photo by Daniel Lara)

In addition to the normal group of test and project personnel, foreign representatives observed the test. Military and civilian representatives from five allied countries that use, or are considering the adoption of GMLRS launchers, came to observe the test and get first-hand insight into the new warhead system.

"The international community being here represents an opportunity for those countries to maintain commonality with the United States Army," Stephens said. "They all have an area effects requirement and a desire to maintain commonality with the rocket launchers they have in place today."

Army officials chose WSMR as the location for the test because of its experience with the GMLRS family of systems and test and support infrastructure.

"The capabilities at White Sands are not replicable in the world, so it's a unique capability that we've had to take advantage of," Stephens said.

WSMR's support for tests like this includes a small army of engineers, technicians and other specialists to allow for the launch of the rockets, and the collection of the mountains of data needed to generate the final, accurate evaluation of the systems performance and function.

"Bringing all our assets together, our analysts, our test conductors, collecting the video, telemetry, optics, data is a critical part of that. Each one of those provides the data that is required for the operation," Tyree said.

Alternative Warhead Project officials plan to continue the testing and evaluation process of the system at WSMR later this year. ■

NIGHT TURNS INTO DAY

Army researchers enable night lethality

BY KIM BELL, CERDEC NVESD PUBLIC AFFAIRS

In complete dark from significant standoff, Soldiers use medium wave infrared, or MWIR, technology to turn night into day. (U.S. Army photo)

The same image and conditions apply using long-wave infrared, or LWIR technology. (U.S. Army photo)

In science fiction, technology problems are solved with the stroke of a writer's pen. In reality, science and technology research takes time and a lot of effort.

"If you've seen the movie Predator, you've seen a perfect illustration of the process of lethality," said Dr. Don Reago, director of the Night Vision Electronics Sensors Directorate of the U.S. Army Communications-Electronics Research, Development and Engineering Center at Fort Belvoir, Va. "First, you must identify your target and if in fact it is a target, then you can move in and eliminate the threat."

In the movie, the predator identifies targets using thermal technology and deducing whether or not they are carrying weapons.

"If potential targets were unarmed they went unharmed, much like how our warfighters operate at present," Reago said. "Today, the Army's goal is to improve situational awareness for Soldiers, resulting in increased survivability, decreased civilian casualties and accurate lethality when necessary."

At NVESD, Army researchers are developing sensors, like the thermal sensors from Predator, as well as image intensification.

"With every advancement, we're able to refine our work, build upon it and make it better," Reago said. "We use every opportunity we can to make our sensors smarter, lighter and smaller."

Sensors increase the odds of survivability by limiting unnecessary casualties and targeting threats. One such development is a consolidated control platform for multi-sensor systems. This fully integrated approach improves Soldier efficiency and allows the user to accurately detect, locate and then target threats.

The Multi-Function Video Display, or MVD, provides a touch screen interface for viewing and controlling all attached subsystems by combining all of the disparate control and display hardware into one universal interface.

"Having all sensor outputs controlled by one integrated system allows for improved target detection performance through the statistical combination of algorithmic processing results," Reago said. "At NVESD, we're able to understand the problem and create an effective, cogent and straightforward solution to overcoming that problem."

The Army's premier scout sensor is the Long Range Advanced Scout Surveillance System, or LRAS3, also a science and technology effort from CERDEC NVESD. This long-wave infrared thermal imager, Day TV camera and a differential GPS-based far-target location system gives Soldiers the ability to detect and locate threats long before engaging targets with any direct action.

"By imaging scenes in the infrared, our warfighters are afforded additional capabilities to detect threats through smoke and fog with imagery stability over day, night and temperature extremes," Reago said. "After identifying the threats, Soldiers have the capability to target these threats using CERDEC NVESD-developed micro-laser technology."

Multiple athermal laser designs were developed over the last 10-12 years and have resulted in a significantly lighter weight and more compact man-portable laser designator/marker. Athermal means a process that does not involve either heat or a change in temperature. These NSVESD athermal laser designs are based on minimal electronics, Reago said.

The Army continues to look for advances in waveguide technology to provide advanced displays that improve ergonomics and Soldier situational awareness. These new displays can provide Soldiers with a wearable display, which is coupled with advanced algorithms and symbology to improve overall lethality.

"CERDEC NVESD is at the cutting edge of these types of displays for both Soldier-borne and vehicle-based platforms, slowly giving our Soldiers capabilities much like the predator from the future," Reago said. "The work conducted at NVESD really matters to our Soldiers; the technology helps accomplish the mission while saving lives."

Army general killed in Afghanistan

The U.S. Army and Aberdeen Proving Ground community mourn the loss of Maj. Gen. Harold Greene, who was killed, Aug. 5, during an attack in Kabul, Afghanistan.

Greene had been serving as the deputy commanding general of the Combined Security Transition Command, since January 2014.

Fellow Soldiers, colleagues and friends remember Greene as an outstanding officer and a family man.

Dale A. Ormond, director of the U.S. Army Research, Development and Engineering Command, expressed his condolences in a message to the workforce.

"Many of you who knew and served with him know the impact he had on this command and its people. The loss of Maj. Gen. Greene is certainly felt across the Army and this Enterprise," he said. "He dutifully served the people of this great nation and dedicated his time at this command making sure Soldiers came first.

"We will remember Maj. Gen. Greene as a great Soldier, officer, and member of our family," Ormond said. "He was a man of uncommon and exemplary professionalism, competence, and candor, in the most profound way."

Greene served as the RDECOM deputy commanding general, from May 2009 to May 2011.

Read more at http://www.army.mil/article/131289/

Heidi Shyu, Assistant Secretary of the Army (Acquisition, Logistics and Technology), hosts a promotion ceremony for Maj. Gen. Harold J. Greene at the Fort Myer, Va., Officers Club, Aug. 30, 2012. (U.S. Army photo by Tom Faulkner)

Aviation, missile engineers welcome new leader

The U.S. Army announced it is filling a senior leadership position responsible for aviation and missile research.

James B. Lackey Jr. has become the director of the U.S. Army Aviation and Missile Research, Development and Engineering Center at Redstone Arsenal, Ala.

AMRDEC is part of the U.S. Army Research, Development and Engineering Command, which has the mission to develop technology and engineering solutions for America's Soldiers.

"The RDECOM Board of Directors and I are very pleased to have someone of James' qualifications in the director's role permanently," RDECOM Director Dale A. Ormond wrote in an email to the workforce.

Since January 2013, Lackey has served as director of the Engineering Directorate within AMRDEC. In January 2014, Lackey became acting AMRDEC director.

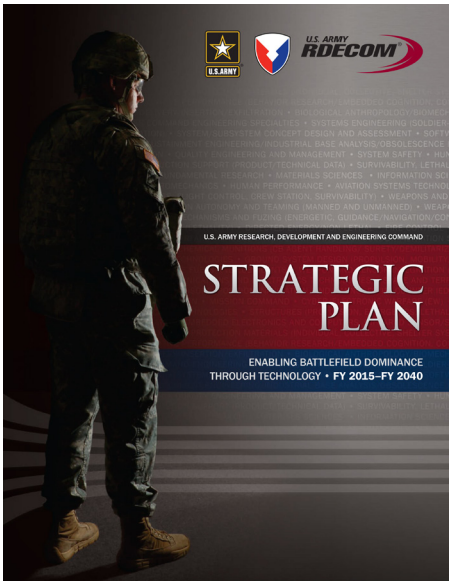
Lackey's first senior executive service assignment was with the Office of the Secretary of Defense supporting the under secretary of Acquisition, Technology, and Logistics as the director of Air Warfare programs.

Read more at http://www.army.mil/article/130686z

RDECOM releases strategic plan

The U.S. Army Research, Development and Engineering Command released a new strategic plan Aug. 14, 2014, which outlines the organization's mission, goals and vision.

"As the Army's premier go-to organization for science and engineering expertise, operating in the space between the state of the art and the art of the possible, we will empower, unburden, protect and sustain the Soldier as we develop and transition innovative technologies and engineered solutions to our Soldiers, enabling the Army's success in combat and future contingencies," said RDECOM Director Dale A. Ormond in the publication foreword.



Ormond said the organization's core tenants emphasize a commitment to providing the Army with "leading edge technology required to accomplish its mission to defend the nation."

"This technology will maintain or improve combat power with enhanced protection, lethality, maneuverability, and command and control. At the same time, the enterprise will conduct the critical RD&E to provide innovative, leap-ahead capability to ensure Army dominance on the battlefield of 2030 to 2040 and beyond," Ormond said.

Officials said RDECOM will focus its efforts to achieve four strategic goals:

- Grow land combat power through research, development, and engineering to develop innovative technologies and to inform the Army's investment decisions
- Invest aggressively in human capital and infrastructure to strengthen and grow the intellectual capital of RDECOM's core competencies
- Establish and develop a systems engineering culture to integrate increasingly complex systems requirements, technologies, and capabilities
- Expand and leverage RDECOM's global partnership base to generate innovation and enhance interoperability

RDECOM provides the Army with an organic research and development capability. More than 17,000 Soldiers, civilian employees and direct contractors form this team. As part of that team, there are 11,000 engineers and scientists, many of whom are the Army's leading experts in their fields.

"RDECOM's focus also aligns with the Department of Defense science and technology objectives to close capability gaps, address emerging threats, reduce acquisition and sustainment life cycle costs, and provide the innovative technology that will change the nature of the fight," Ormond said.

The 50-page document is available for download at http://www.army.mil/rdecom.

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The International Pyrotechnics Society awarded its 2014 Dr. Bernard E. Douda Young Scientist Award to chemist Anthony Shaw from Picatinny Arsenal, N.J., for groundbreaking research to find environmentally benign chemicals for smoke grenades that Soldiers use for screening on the battlefield.

The International Pyrotechnics Society is an international organization that promotes and shares research relating to the field of pyrotechnics. The award identifies a member whose research shows a significant contribution to the field of pyrotechnics. The applicant must also be younger than 40. The research team's success with boron carbide smoke grenades has inspired Shaw to look further into ceramic materials in pyrotechnics and energetic materials, goals that he hopes may serve as a catalyst for future projects.

Scan the QR code or go to **http://www.army.mil/article/123158** to read more.