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### Solutions

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**Digital Version**

For the digital version of this newsletter, please visit:  
http://www.cbc.ccdc.army.mil/solutions
In his memo, MG Wins also discusses the new CCDC vision and mission statements:

**Mission** - To provide the research, engineering and analytical expertise required to make Soldiers more lethal and deliver combat capabilities.

**Vision** - To be the Army’s scientific and technological foundation through world-leading research, development, engineering and analysis.

The CCDC Chemical Biological Center is the only organization in the Army with the expertise and facilities to fulfill the CCDC mission and vision within the chemical and biological defense arena. We are a critical element across a spectrum of modernization efforts that spans CCDC, AFC and the Army, and that makes collaboration a mission-essential priority. Whether working with the Army’s Cross Functional Teams, our sister laboratories, industry or academia, strong collaborations are a key element in fulfilling our role under the Army Futures Command.

**The CCDC Chemical Biological Center is the only organization in the Army with the expertise and facilities to fulfill the CCDC mission and vision within the chemical and biological defense arena.**

We’ve come a long way in a year. We’ve made fundamental changes in the way we do business, and we’re examining those practices in a formal review process to develop an awareness of where we’ve been, where we’re going, and what changes will get us there. I echo MG Wins’ guidance to continue to embrace change, to take smart risks, and to seek new opportunities for collaboration. New partnerships, expanded opportunities to work directly with warfighters, and our ability to have a positive impact on modernization efforts across the Army make it an exciting time to work at the Center.

**Cum Scientia Defendimus!**
(With Science We Defend)

Eric L. Moore, Ph.D.
Director, CCDC Chemical Biological Center
To create a more realistic training environment for CBRNE warfighters, the Chemical Defense Training Facility team worked with graphic artists at the CCDC Chemical Biological Center, developing composite photography and 3D renderings to transform each target location from a seemingly simple brick and mortar room into a realistic, near-peer location warfighters may be deployed. See what the new facility looks like on page 20.

The Center’s Advanced CBRNE Training Branch led 80 U.S. Army National Guardsmen through decontamination training leading up to the United Nations General Assembly held in New York City. The training prepared Guardsmen for decontamination of VIPs and dignitaries attending the assembly in the event of a CBRN attack.

During a weeklong chemical/biological culminating exercise of an Integrated Early Warning Advanced Technology Demonstration known as Perceptive Dragon 3, a team of researchers from the Center led 22 Marines and Airmen through a four-phase amphibious raid, force build-up and urban assault. Utilizing physiological status monitoring, unmanned aerial vehicle flight controls, unmanned ground vehicle control, a variety of CBRN and non-CBRN sensors, sensor data analytics and correlation engines to support multi-domain decisions, warfighters provided valuable feedback on the technology.

Researchers from the Center met with warfighters, stakeholders and other interested parties at Camp Dawson for the second annual Chemical Biological Operational Analysis (CBOA) to showcase and garner feedback for their technologies. The Center was well represented with six technologies showcased and 26 subject matter experts in attendance. Researchers came away from the DTRA-held event with quality feedback from warfighters they can incorporate into future iterations of their technologies.

Center researcher, Erin Durke, Ph.D., won an award for outstanding work at the International Conference on Aerosol Science and Technology. Durke presented research on surface charge of aerosol particles titled Characterization of Particle Charge from Aerosol Generation Process: Impact on Infrared Signatures and Material Reactivity. Read more about her research on page 24.

The CCDC Chemical Biological Center in the Field

Missouri

New Jersey

Virginia

West Virginia

Prague, Czechia
THIS YEAR MARKS AN EXCEPTIONAL YEAR for U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center Chemist Joseph Myers and his sprayable decontaminant slurry.

After three demonstrations between March and June 2019, the slurry has more than met expectations and it could be in warfighters’ hands in as little as three to five years.

It’s been five years since Myers began working on the paint-like substance that can decontaminate an entire vehicle quicker and more thoroughly than the previous method of washing it down with soapy water, and it does so with a fraction of water.

“Just a quart-size sprayer filled with slurry can decontaminate up to 50 square feet of vehicle surface and have it back in action as fast as a warfighter can spray it,” Myers said. “The cool thing about the slurry is that it stays where you put it.” Decontamination can continue even when the vehicle is in use.

The slurry works by employing a blend of hydrolytic and oxidative chemistries with a small amount of water, solvent, and binder. Because the active ingredients react readily with both blister and nerve agents, it can detoxify a range of chemical warfare agents.

In small-scale laboratory studies, Myers has put the slurry to test on the blister agent HD, commonly known as mustard gas, as well as nerve agents GD, or "soman", and VX.

HD was used for the first time in 1917 during WWI by the Germans against the Allied Forces, causing more than 2,100 casualties. Although banned in 1925 by the Geneva Protocol, the garlicky or mustard-smelling agent was used recently in the civil war in Syria. In addition to blistering the skin, it can cause temporary blindness and even death by way of hemorrhaging of the lungs.

Odorless and tasteless, the nerve agent VX is one of the deadliest chemical warfare agents. It was used to kill the half-brother of North Korean leader Kim Jong-un.

Following successful lab trials on two-inch panels against multiple chemical agents between 2014 and 2018, Myers graduated his research to large chamber testing.

“This was the first large-scale study for the slurry with neat, or undiluted, chemical warfare agent,” Myers said. “As technologies develop, they need to be proven out on a larger scale.”

Upon receiving additional funding from the Defense Threat Reduction Agency (DTRA), Myers began designing an appropriate large-scale test item for use in the center’s Engineering Directorate Toxic Chamber facility.

“Just because we are testing in a large-scale chamber, doesn’t mean we requisitioned a Humvee and sprayed agent all over it,” Myers said. “Although the facility has the ability to accommodate that kind of work, whatever item we test with has to be disposed of in accordance with local, state, and/or federal regulations as hazardous waste. The test article needs to mimic the attributes of a full-scale vehicle, while being a manageable size for waste disposal.”

Instead of a full-sized vehicle, Myers designed an 18-in. X 24-in. miniature vehicle door with a window, door handle, seams, screws and threads – all of the things one would expect to find in a typical vehicle door. Testing the slurry on a realistic scenario has to continue to advance the technology readiness level (TRL). Decon slurry currently sits at TRL 5 where researchers must demonstrate the project at an operationally relevant scale. Each readiness level thereafter moves the project closer to field testing. In the end, if everything goes well, decon slurry could be included in a program of record for the Army.

During large-scale testing, operators contaminated doors with HD and
contaminated other doors with VX. Doors were decontaminated using the typical method of soapy water and with Myers’ decon slurry.

“For HD, after using the slurry, we could not find any contaminant at all, and a significant amount was applied initially,” Myers said. “With VX, we had one spot of residual agent, and that was a screw thread so it was a place where the slurry simply could not access, which is typical.”

Compared to the soapy water wash down, the slurry performed well.

“It was multiple orders of magnitude better efficacy and better removal using the slurry,” Myers said.

With that outcome, Myers and fellow chemist Janlyn Eikenberg found themselves on a plane to Hawaii the following March to demonstrate the slurry and brief the U.S. Army Pacific Command on the slurry’s development and use.

With the help of private sector company FLIR, who partnered with Myers, the two provided a demonstration of a process called “tactical decontamination”. Tactical decontamination refers to a rapid process in which warfighters use an indicator to locate contamination on their vehicle and a decontaminant to mitigate the contamination.

“The other technology integrated into our demo is called CIDAS – Contaminant Indicator Decontamination Assurance Spray,” Myers said. “CIDAS is an indicator technology. If you spray it on a surface, it will change color in the presence of agent.”

Using a simulant, the FLIR presenter marked the door Myers designed with a large “X”. She then sprayed the door with CIDAS, which indicated the presence of a contaminant by turning red.

“We then sprayed the door with the slurry. There is a waiting time associated with the slurry. You need time for it to react. We then rinsed off the slurry and applied the CIDAS again. This time, the indicator did not change to red, indicating decontamination was successful,” Myers said.

With success in Hawaii, Myers and Eikenberg demonstrated the slurry’s capability in June, in Germany, once at Ramstein Air Base to the U.S. Air Forces Europe and another in Grafenwoehr to the U.S. Army European Command Chemical Biological Radiological Nuclear Explosive Detachment.

The whole idea behind tactical decontamination is that Soldiers could decontaminate a vehicle quickly and get back in the fight and that goes toward Army readiness,” Myers said. “Without the slurry, you’re basically out of commission until a decontamination unit arrives to do a soapy water wash. The point is to get warfighters and their equipment back in the field as fast as possible, and the slurry does that.”

Currently, those decontamination units rely on hundreds of gallons of water – something that can be hard to find in some environments or have at the ready. Containing 10 percent water, the slurry eliminates that need.

Not just the commands were impressed by the slurry’s performance. DTRA is also enthusiastic about Myers’ product. They have committed to providing funding for the design of a custom and battle-hardened sprayer for the slurry. Up to now, the slurry has been demonstrated with a commercial-off-the-shelf paint sprayer.

Even more good news has come from Myers’ demonstrations. Another private sector company will soon enter into a cooperative research and development agreement with the Center to openly share information in an effort to refine the formula and advance the slurry so that it can be in the hands of warfighters in the next three to five years. ▲
Mobile Test Chamber Eases Challenges for Conducting Gas Mask Tests

By Shawn Nesaw

PROTECTION FACTOR (PF) TESTING ALLOWS THE U.S. ARMY and other military branches to determine how effective chemical biological protection masks are during use by warfighters. During a test, warfighters don their protective masks, step into a test chamber and are put through a series of movements while aerosol simulants are pumped into the chamber.

Each mask receives a score based on how effective it was at protecting the wearer from the simulant. With protective masks in use in all branches of the military, in different parts of the world, conducting protection factor tests is a challenge for researchers when it comes to shooting a weapon while wearing a gas mask.

Steven Yurechko, a chemical engineer at the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center, decided it was about time to provide a solution to the challenges he and others face when attempting to conduct these types of protection factor tests with the most critical challenge being a way to provide a uniform, consistent aerosol challenge.

Yurechko needed a way to conduct live-fire tests from inside a test enclosure while maintaining the correct concentration of aerosol simulant to ensure proper test results. The enclosure also had to be mobile enough to easily transport to firing ranges or other customer test sites.

Yurechko looked to what was readily available, an off-the-shelf, inflatable paint spray booth.

"It inflates just like a bouncy house you see at a kid's birthday party," Yurechko said. "We installed custom ventilation ports into the interior of the chamber so that aerosol simulant can be pumped into the chamber directly through the blower which is used to inflate it. This ensures uniform aerosol concentration throughout the interior which meets the joint service standard for conducting protection factor testing."

The interior directional air ports concentrate the simulant toward the back of the chamber where the test subject stands while the front chamber door can be fully opened to allow for rifle fire without damaging the enclosure.

After performing extensive chamber mapping tests to confirm that the aerosol dispersion met the current joint service standard for testing, Yurechko then took the inflatable chamber and the scientific instruments needed to conduct a protection factor test to Aberdeen Proving Ground to prove that his inflatable test chamber concept could easily be set up and would actually work for a live fire test.

"The whole set up fits in three ruggedized cases and one of those cases doubles as a table to organize the testing devices," Yurechko said. "Setup took a total of about 10 minutes with two personnel. Inflating the chamber itself took less than a minute."

Accompanying Yurechko down range was a group of Center researchers willing to don a gas mask and fire rounds down range from inside the chamber.

"We had concerns that the expended bullet casings would be hot enough to damage the nylon interior of the chamber, causing it to collapse," Yurechko said. "We installed protective fabric panels in areas we thought a casing might hit or become lodged which helped, but overall, even casings that did come in contact with the chamber didn't damage it."

Pleased with the overall performance of the chamber, Yurechko is already busy making improvements to the mobility and form factor of the test setup as well as improvements to the data acquisition system. Yurechko has already received positive feedback from colleagues and interest from several organizations eager to put the portable test chamber to use.

If live-fire testing isn't necessary, the enclosure can also act as a mobile, stand-alone PF chamber. For some tests, customers require that actual end users of the masks act as test subjects.

"Until now, conducting a test was a slight logistical nightmare due, in part, to scheduling travel for multiple warfighters to come to the Static PF Test Facility at CCDC CBC where the test was being held," Yurechko said. "It was time consuming and expensive for the Army."

Zach Chadwick, a chemist at the Center, was recently supporting protection factor testing for pilots of the Rotary Wing Program which was conducted at the Static MIST Facility at the Center.

"This new test chamber that would have been ideal for our purposes because it travels easy and we can take it to the pilots instead of having them come to us," Chadwick said. "The portability factor alone makes this a worthwhile capability, but then you add on the option to test masks while actually firing rounds down range, something that up to this point hasn't been reliable, and you've got something special."

Funding for the project came from the Center’s Fiscal Year 2019 Innovative Development of Employee Advanced Solutions Program designed to give researchers with promising new ideas seed money to develop them. It was one of eight projects chosen from a field of 17 to receive funding.

Photo by Shawn Nesaw
Iodine Grenade Could Provide Biological Decontamination

By Gay Pinder

CRITICAL TO MILITARY OPERATIONS is the ability to easily ensure books, papers, computers and electronics recovered by warfighters in the field are free from biological hazards. Researchers at the U.S. Army Combat Capabilities Command (CCDC) Chemical Biological Center are working on a device that could get the job done with the pull of a pin.

Amee Polk and Mike Kauzlarich are working with iodine smoke, a step along the path to developing an iodine grenade and other iodine delivery mechanisms to make the retrieval of information materials safer for the warfighter.

"When warfighters are out in the field, there's some concern that they may be exposed to biological agents," engineering technician Kauzlarich said. "Warfighters may carry an assortment of information materials, from papers to PCs. Before gathering those materials to return to basecamp, they would have to undergo decontamination for possible biological agents.

In cases of a biological threat, like Ebola, the typical decontamination method is to spray everything with bleach. "It's incredibly corrosive," Kauzlarich said. "If warfighters hope to preserve information, they need another method of decontamination that leaves the files intact. Our idea was to come up with something that they could use without destroying the files."

"You could conceivably pull the pin on the grenade, roll it into a room or tent and shut the door and wait while the grenade does its work," Polk described.

The idea for the iodine grenade was sparked by another study the pyrotechnics team, including Pyrotechnics Branch Chief Nino Bonavito, read about a university that was firing a shotgun primer at a thin film of metal coated with iodine in an attempt to vaporize the iodine.

By using iodine pentoxide (an iodine compound with a lot of oxygen), Polk said the team was convinced they could generate iodine more efficiently.

"We combine iodine pentoxide and a copper metal powder and apply heat to it," Polk revealed. "This is a thermite-like reaction, where the oxygen switches from the iodine pentoxide, liberating the iodine, to the metal fuel. The oxygen then bonds with the copper and we get copper oxide."

Free of propellants, the grenade works like a roadside safety flare or a bug bomb. Once engaged by pulling the pin, the grenade emits a purple smoke that Polk and Kauzlarich call Ravens smoke (an allusion to Baltimore's NFL team).

"Because it vaporizes, the iodine can get into all the nooks and crannies of items in a room," Polk said. "You can't ask warfighters to jump out of an airplane in the middle of the night carrying a 55-gallon drum of bleach," he said. "We can give warfighters various forms of this iodine grenade to lighten their load – everything from little capsules to a grenade to a smoke pot and they could place these in a room to kill the organisms, ensuring the safety of the warfighter."

The iodine grenade is effective against spores and vegetative cells – a cell that is not actively growing. Resistant to heat, radiation and chemicals, spores are some of the hardest life forms to kill.

"We achieved 7 log reduction – total death, complete kill," Polk said. "It's very difficult to break that outer shell of the spore and the fact that we were able to kill those is huge."

Polk sees yet another advantage to the grenade. "It's almost impossible to develop a resistance to iodine. It's a small molecule so it penetrates the membranes of the organism and they can't build up a resistance like they can to an antibiotic. There is no pathway for the cell to protect itself."

Polk also sees a broader use for the grenade beyond the warfighter. She said the iodine grenade could also be used by first responders and healthcare workers in the field. "You could use it like a bug bomb and knock a biological threat down, so you don't have to go into a contaminated site wearing level A [the highest level of personal protective equipment]."

So far, the team has tested the grenade only in the lab chamber using a 20 gram pellet. Next steps include perfecting the ratio of iodine pentoxide to metal fuel, defining contact time and testing the grenade in a larger space like a room or house.

"All the things you need money to do," Polk said.

Armed with the Bernard E. Douda Young Scientist Award she recently received from the International Pyrotechnics Society, Polk will present the project to the Defense Advanced Research Projects Agency (DARPA) with the hope of gaining funds. Those funds can't come soon enough for the team.

"It's only a matter of time until we run up against some real biological threat," Kauzlarich warns. "A commander doesn't want to hear about problems, he wants to hear about solutions and we're supposed to have the solutions before the problems emerge."
IMAGINE HAVING THE ABILITY TO GROW ELECTRONIC COMPONENTS using living bacteria. That idea was the inspiration that biologist Alena Calm and research scientist Kelley Betts at the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center drew upon to come up with their FY19 Innovative Development of Advanced Employee Solutions Program project.

Together, the scientists are developing technologies that leverage the unique properties of bacterial magnetosomes—biologically-derived nanoparticles that have a number of superior properties that include high chemical purity, low toxicity, a high degree of crystallographic perfection and permanent magnetization.

Mission Focused

Knowing that the warfighter is routinely burdened with the weight of electronic devices designed for communication, agent threat detection and other field purposes, Betts and Calm considered the idea of using magnetosomes to develop the next generation of lightweight electronic devices.

“A lot of threat agent detecting sensors are going paper-based because they are logistically easier to use,” Calm said. “Chemical sensors can be bulky and require power to operate. Energy sources, even triple ‘A’ batteries, add weight to the warfighter’s pack which is a logistical challenge many researchers are seeking to overcome.”

“It’s weight. It’s logistics. It’s all of the above,” added Betts. “Our thinking was to help make the power sources used in remote or field-forward sensor applications more paper-based, bringing the idea of lightweight — perhaps even disposable — electronics to the forefront of research.”

“We began to think; so how are we going to come up with things that are lighter and cheaper?” Calm said.

The Research

Participating in the Center’s Biological Engineering for Applied Materials Solutions (BEAMS) nanocellulose competition last summer led Calm and Betts to speculate how they could leverage what they had learned from the competition for their current work with magnetosomes.

“That’s where we started brainstorming and working with the idea of magnetically infused paper,” Calm said. “One crazy thought led to another,” she said, ending with Betts coming up with the idea of a biologically-derived transformer core.

“The idea is that you could make transformers really, really small, even as thin as a piece of paper,” Calm reiterated.

“It’s very out there. Very Star Trek,” Betts chimes in.

“But in theory, it will work.” Calm finishes.

The first step on their futuristic journey required proof that the team could coax the magnetotatic bacteria M. gryphiswaldense to produce magnetite nanoparticles.

Long strings of membrane-bound magnetite nanoparticles called magnetosomes are produced within the bacteria when they are deprived of oxygen. In their search for oxygen, the strings of magnetosomes serve as a kind of internal compass that lets them navigate to a more oxygen-rich environment using the Earth’s geomagnetic field.

It takes countless strings of magnetosomes to further Calm’s and Betts’ goal. Growing the bacteria on a bigger scale has been successful, with 20 liter batches grown Continued on page 10

By Gay Pinder
“We are going to grow our non-conductive nanocellulose layer,” Calm explained, “and then we’ll overlay it with a culture of magnetic bacterial magnetosomes that will be guided with powerful magnets into a pattern.”

The resulting pellicle or thin film will then be processed, dried, and cut and/or folded into a transformer core comprised of paper-thin alternating conductive and non-conductive layers.

“We’ll then test the transformer by measuring the output of the circuits,” Calm said. “It should increase the electrical output compared to our control that would be wrapped with just plain nanocellulose layers without the magnetosomes in between.”

“The dream is that with these kinds of living materials, we’re changing the paradigm,” Betts said.

“It’s not a metal. It’s something that’s alive and maybe these could, down the line, work into materials that could self-repair.”

Currently, the medical field is investigating magnetosomes for applications such as medical imaging, drug delivery and cancer research.

“This is just one strain of bacteria that we are working with,” Calm said. “There are many. They come in different shapes and sizes and sequester different metals like gold and silver. Years down the line you may want a nanoparticle that’s a certain size or a certain shape and a certain metal.”

A Green Solution

But for now the two researchers are content to work with the magnetosomes produced by M. gryphiswaldense, nanoparticles that have the added benefit of being greener to generate.

Unlike their synthetic counterparts, magnetosome nanoparticles are more environmentally friendly to produce, requiring much less energy for production and no hazardous chemicals for their fabrication.

“If you make nanoparticles synthetically, it’s a dirty business,” Calm said. “They are not environmentally friendly to produce, whereas biologically-derived magnetosomes are. They are found in the environment, and can just go back to the earth when we’re done with them.”

Betts and Kim have also authored a proposal to research the use of nanoparticles in reclaiming rare earth.

“With that idea, Betts and Calm theorized perhaps alternating layers of non-conducting nanocellulose and magnetic magnetosomes could work together to make the first, ultra-thin, biologically-grown transformer.

“We recalled that if you make a transformer core out of a solid piece of metal, it can develop small eddy currents which can cause the transformer to lose energy,” Betts explained. “But if you use laminated layers of conductive and nonconductive sheets to make the core, these currents get really small, and the transformer doesn’t lose as much power.”

Moving Forward

If their circuit output test proves successful, the two will next try to use the transformer to create paper-based circuitry. But before that can happen, they will need more funding.

Already, one major defense contractor has contacted the pair to discuss ways to grow the magnetosomes faster. Betts and Calm are eager to continue their research.

“It’ll be really interesting because it is a proof of concept project that will hopefully spark the interest of other scientists who see the work that we’re doing and will want to collaborate,” Calm said.

Given that the convergence of material science and biological engineering has seen significant interest and investment by the Department of Defense, Calm and Betts are hoping their efforts will help towards the development of never-before-seen materials that are able to meet the unique requirements and challenges of the defense environment of the future.
The U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center develops new, innovative technologies to support the warfighter. Those same technologies can also benefit industry, academia and other government entities.

Through a robust and proven technology transfer program, industry, academia and other government entities can access our innovative technologies, cutting-edge federal resources, facilities and researchers.

**COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT (CRADA)**

- Provide a means for private industry and academia to collaborate with research and development activities
- Open exchange of intellectual property, personnel, equipment, expertise and data
- Cannot commit funds to non-federal parties
- Material transfer agreements allow for the exchange of material between parties for research purposes

**PATENT LICENSE AGREEMENT (PLA)**

- Commercialize federally owned technology for the benefit of the U.S. economy
- License intellectual property rights from the government
- Exclusive, partially exclusive or non-exclusive basis
- Over 200 patents available

**TECHNOLOGY SUPPORT AGREEMENT (TSA)**

- Provide services, facilities and equipment to interested parties for testing or training
- Fee for service
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**FIND OUT MORE!**

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND CHEMICAL BIOLOGICAL CENTER, OFFICE OF TECHNOLOGY TRANSFER

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Researchers at the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center are looking to LEDs to help warfighters battle against chemical warfare agents (CWA). Co-primary investigators, Hui Wang, Ph.D. and John Landers, Ph.D. are investigating ways to embed tiny light sources in warfighter uniforms.

“This project is based upon Dr. Wang’s research published in the scientific journal American Chemical Society Applied Materials and Interfaces, where he relayed how light-emitting diodes (LEDs), in conjunction with photosensitive dyes, could be used to enhance the degradation of chemical warfare agents like mustard gas,” Landers said.

Chemical weapons like mustard gas (HD) have been a part of warfighting for over a century. Their use has increased over the last two decades both in warfare and in focused assassinations and attempted assassinations. Enhancing warfighter safety by detecting chemical warfare agents and decontaminating items that come in contact with them is an ever-present focus of the CCDC Chemical Biological Center.

In addition to the work published by the American Chemical Society, the pair also entered Wang’s research into the Center’s Innovative Development of Employee Advanced Solutions (IDEAS) Program designed to give researchers with promising new ideas seed money to develop them. It was one of eight projects chosen from a field of 17 to receive funding.

The LEDs work by way of photocatalysis, meaning the light starts the chemical reaction necessary to break down the CWA.

“Some chemicals break down under light and some chemicals break down even easier under certain wavelengths of light, let’s say a red LED, a green LED and blue LED,” Landers explained. “The purpose of the blue LED is to activate a dye that in turn generates a reactive oxygen that breaks down these chemical agents.”

Wang and Landers’ work with borondipyrromethene (BODIPY), an organic compound that acts as a photosensitizer – a molecule that brings about a chemical change in another molecule (decontamination of the HD molecule in this case) in the presence of light.

“The LED initiates the reaction, activating the dye-like BODIPY and the BODIPY, when exposed to LED light, converts the nearby oxygen to a more reactive form,” Wang explains further. “It’s that reactive oxygen that breaks down the chemical agent. It all begins with the LED.”

Because warfighter safety often relies on stealth, Wang and Landers realized that light emitted from LEDs would need obscuration.

“Instead of taking an LED and applying it to the surface of clothing, we will incorporate small LEDs with an ink jet-printed circuit between layers of a uniform allowing the LEDs to safely activate if a warfighter suspects an agent threat,” Landers said.

Wang and Landers solution to masking the light emissions will use conductive silver inks to affix the ink-jet printable circuits and LEDs to one layer of fabric and then cover them with a light-obscuring material.

“Both layers are breathable, and that’s one of the main goals of this project – to make a self-decontaminating fabric that’s still breathable and reduces the physical burden to the warfighter,” Landers said. So although they will add more layers to warfighters’ protective clothing, they won’t add significantly more weight.

The two researchers are looking to include metal organic frameworks (MOFs) to their research.

“Photosensitizer-containing MOFs will be an alternative to replace the BODIPY dye,” Wang said. “The advantage of photosensitizer-containing MOFs is that they not only can...”

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adsorb the chemical warfare agent, but also decontaminate them after adsorption."

The MOF fabric will literally add an extra layer of protection, with the nanoparticles working like tiny sponges to absorb the agent before it reaches the warfighter.

"The CBR Filtration Branch has years of experience testing different MOF materials for decontamination of chemical warfare agents," Landers said.

Wang and Landers intend to apply for additional funding from strategic public and private partners. Next steps include adding sensors to detect exposure that work in conjunction with the LEDs’ and MOFs’ abilities to decontaminate.

So far, the project looks more than promising. The LEDs eliminate the need to provide a solution-based decontamination method, so the system is ideal for low-resource environments. Wang and Landers have also found the decontamination process is rapid.

Wang says the half-life of the mustard gas (the time it takes for half the chemical to be removed) is under a minute.

"We want to retain that same reactivity when we incorporate the dye and the LED circuitry into the fabric," Landers added.

The two researchers say that the Department of Defense has invested more than $100 million into wearable tech. "We're just trying to converge the two interests -- wearable tech and decontamination," Landers finished. ▲

Internship Program Continues to Offer Opportunities

By Gay Pinder

JUNE USHERED IN THE SUMMER 2019 INTERNS for the Minority Undergraduate Student Internship Program aimed at providing undergraduate students with the opportunity to work with top scientists and engineers on challenging research projects in support of the nation’s defense.

Nine students participated this year in the opportunity to enhance their education by working on real-world science, technology and engineering research projects alongside Center researchers. The program also supports the Center’s ongoing goal to strengthen its workforce, promote diversity and encourage students to pursue careers in science and engineering.

Brooke Fortune, one of only two young women in the program, and a junior at the University of Tennessee, got off to a good start.

"I really like where I’m working. It’s called the TREB — Testing Reliability Evaluation Branch," Fortune, a bio-medical engineering major, said. "I’m working with testing filtration systems and filters with DMMP [dimethyl methylphosphonate, an irritant] pumping through them in different tests."

Fortune is working with a small group of engineers and chemists, and is looking forward to the lab work.

"I think I will like what I’m doing. It’s a process. I think the hardest thing to learn is all the abbreviations for everything," she revealed.

Like Fortune, each student was assigned a Center researcher who acts as a mentor throughout the 10-week internship.

Andrew Pfadenhauer — of rural Monkton, Maryland, has been reading standard operating procedures to prepare for his work under mentor Jana Kesavan in the Center’s Sensors, Signatures, and Aerosol Technologies Branch. It may be exactly the right entry point for the Towson University cellular and molecular biology major.

"This is my first true lab experience outside of school," Pfadenhauer said. "I’ve worked in labs before, but I never had lab responsibilities like I will here."

But Pfadenhauer’s skills of observation are serving him well. "You don’t really think of the decontamination and filtration that they do. You just think of chemical and biological weapons and manufacturing," he said. "You never see the side of scientists going overseas and dismantling other people’s chemical and biological weapons. It’s very interesting."

Fortune also found that aspect of the Center’s work of interest. Following a tour of the building that houses the Field Deployable Hydrolysis System, Fortune found her interest sparked by the equipment that was deployed aboard a U.S. Maritime Administration cargo ship to destroy Syria’s declared chemical weapons stockpile in 2014.

"The thing that got me into engineering is the hands-on, adrenaline-pumping stuff," Fortune said. "With the right training and knowledge, you can assess the problems and take care of them like they did (during the Syria stockpile mission), which I thought was really awesome."

Aside from lab duties, students will also tour multiple post facilities, interact with Center director, Eric L. Moore, Ph.D. and learn essential communications skills like goal setting, networking and developing and presenting an effective briefing — all important aspects of a career in science. ▲
HOME TO MANY UNIQUE CAPABILITIES, the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center supports the U.S. Army and Department of Defense. While most of those capabilities focus on protecting the warfighter from chemical and biological threats, the Center also continues to develop improvements and innovations as the Army’s science and technology center for smoke and obscurants.

The Center’s history in working with smoke and obscurants reaches back nearly a century to the 1920s, and today its capabilities include the development of new obscurants as well as the world’s most comprehensive obscuration assessment methodologies and facilities.

Effective Assessment Tools

“The Center has its own test range (M-field) for evaluating smoke and obscurants with target boards on a small grid and a large grid, meteorological stations and portable trailers with test equipment to collect data,” Carestia said. “Down range, we can set up a number of tests to evaluate both visible and infrared (IR) obscurants.”

The dedicated test range is outfitted with everything the team needs to effectively and consistently assess obscurants.

Black and white target boards measure the effective screening area of vehicle launched smoke grenades. These are mounted behind the vehicle under test to provide a visual target for cameras and sensors down range. Heating pads are also mounted to the target boards to provide a thermal signature for IR imagers. Effective screening area is a quantitative metric to compare the obscurant performance of all items under test.

Visible and IR imagers view the target boards to record the effect of the smoke grenade and calculate the effective area the smoke obscures.

Infrared blackbodies measure smoke and flame temperatures produced by the smoke rounds. High temperature smoke and flame produced by the smoke grenades can aid in IR obscuration.

“Measuring these temperatures allows us to better understand the effect of the smoke on IR sensors,” John D’Agostino, mechanical engineer said.

Using transmissometers, devices used to measure energy transmission, the team can...
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evaluate the density of obscurant particle in the aerosol, another important factor in terms of obscuration effectiveness.

The test range has weather stations positioned around the test area to measure temperature, relative humidity, wind speed, solar radiation and wind direction.

“These parameters are recorded and noted for each trial,” D’Agostino explained. “Wind speed is included in the effective screening area calculations. By normalizing the wind speed and measuring other weather effects, testing can be conducted with variations in weather that will not skew results.”

The team also uses unmanned aerial vehicles (UAV) to provide an overhead look in the visible and IR spectrum to witness and record the smoke technology range and performance.

“Flying above also simulates the view of an enemy at an elevated position such as a hill, rooftop or even in a helicopter,” D’Agostino said. “Future vehicle launched smoke grenade designs will offer protection for these overhead threats.”

Army program managers use this assessment capability to help make requirements-based decisions. “We’ve had a long standing relationship with CCDC CBC and we value their expert assessments of obscuration technology to help us make decisions,” said Eric Hodges, assistant product manager of camouflage, concealment, deception and obscuration at the Office of the Product Manager for Vehicle Protection Systems in Warren, Michigan.

“One-Stop Shop

“We’ve developed research testing and evaluation criteria we think give a comprehensive assessment of an obscuration technology, analyzing materials in a lab, scaling the material and evaluating in our unique instrumented chambers and then demonstrating that technology at M-field,” Carestia explained. “But it’s not about what we think. We’ve heard from industry partners and organizations that our evaluation methods are exactly what they want in order to make better decisions about what smoke capability is best for their needs.”

In many cases with industry, buyers want to see trustworthy, sufficient data from a defense contractor before they make big purchase decisions. The Center offers reliable, unbiased data reports to aid in the decision making process.

It’s that level of data and results that help guide decision makers involved with developing or procuring these types of items which could one day be used on the Next Generation Combat Vehicle, one of the Army’s modernization priorities.

“A client might come to the Center for one thing but we can offer more than just that one expertise,” Carestia said. “Our SMEs, labs, chambers and unique in-house capabilities, provide a one-stop shop that make the Center a collaborative partner a lot to offer.”

Obscuration payloads filled with brass bi-spectral material burst ahead of a Bradley fighting vehicle, blocking visible and IR in the electromagnetic spectrum.

John D’Agostino answers questions regarding the Center’s obscuration testing capabilities.

“With years of successful past performance, they have intrinsic knowledge about their industry,” Hodges said. “They analyze vendor technology in an unbiased assessment and really, their goal is to see the best system put to use to achieve success. They are our go-to smoke and obscurants resource.”
NECESSITY IS THE MOTHER OF INVENTION.

When the U.S. Army Chemical, Biological, Radiological and Nuclear (CBRN) School’s Joint Experimentation and Analysis Division (JEAD) needed to find a way to get more mileage out of the expensive protective suits worn by Army civil support teams in radiological environments, they looked for answers from what seemed like a peculiar source -- a team of biologists in the Utah desert.

But according to Division Chief Brian Bennett of the U.S. Army Combat Capabilities Development Command’s (CCDC) Chemical Biological Center’s BioTesting Division, it’s not as strange as it sounds.

“Our sole function here,” he explained, “is to evaluate new technologies and techniques for Soldiers. Our area of expertise here is handling aerosol clouds, because that’s how you launch a biological attack. Because radiological fallout consists of aerosolized particles, testing the radiological decontamination techniques fit well within the division’s capabilities.”

JEAD’s Tom Murphy is counting on the BioTesting Division’s expertise. “Right now these suits are one-and-done. Given that the suits are hot, and that the work conducted while wearing them is typically strenuous, civil support teams members work/rest cycle requires at least two suits per day per team member.”

At $2,000 a pop, the costs add up fast.

So the BioTesting Division was asked by JEAD to devise a test to determine whether the protective suits could be decontaminated and reused, and if so, how many times.

In order to answer this question, the team developed a novel plan that was based on an approach they often use in testing biological aerosols, and tailored it instead to this radiological application. The plan involved simulating the radiological fallout through controlled release in their Aerosol Simulant Exposure Chamber of a fluorescent dust known as Glo Germ.

"Initially, we’re looking at how well the decontamination procedures work," BioTesting Division Microbiologist Scott Jonas explained. “We’ll provide that data back to the customer, who may use the data to make some changes to their procedures. Once they have a validated procedure, then we’ll be looking at how that procedure impacts the integrity of the suit, and how many times the suit can be subjected to the procedure before it begins to degrade.”

Soldiers from the Alabama National Guard’s 690th CBRN Company aided in the execution of the plan by serving as test subjects.
Patty Low, BioTesting Division microbiologist, prepares Glow-Germ simulant for the test by loading it into party poppers.

Researchers observe samples taken from the protective suits under a fluorescing microscope.
The three Soldier volunteers entered the chamber, each wearing a different type of protective suit. Simulant was dispersed as the test subjects walked around the chamber for 5 minutes.

“The key to this test is our ability to create a sustained, measurable cloud of particulates for the Soldiers to move around in,” said Kallie Thevenot, a physical sciences technician with the BioTesting Division. “We do that with an initial forceful simulant dispersal and then we sustain the cloud with air currents generated by fans.”

“We used party poppers to disperse threat particles into the air,” said Patty Low, a BioTesting Division microbiologist. “Activating the [simulant filled] popper within the test chamber produced a cloud of dry simulant which we were able to sustain with air currents.”

Evaluators examined the suits under a black light and removed samples from the suits to determine their level of contamination. They further examined and photographed the samples under a fluorescing microscope to provide a more accurate and permanent record of the results.

The researchers then put the Soldiers through decontamination procedures intended to remove the fallout from the protective suits. They inspected the suits again under a black light and resampled, for a second time examining and photographing the samples under a fluorescing microscope. The test was performed five times with dry decontamination procedures and five times with wet decontamination procedures.

Sgt. 1st Class William Anderson was one of the Soldiers participating in the test, and said he values the opportunity to be part of the tactics, techniques and procedures (TTP) development process. “It gives us an opportunity to provide input and make recommendations,” he explained.

Andrew Reichert, a physical scientist with the Homeland Defense/Civil Support Office at the Maneuver Support Center of Excellence, said that TTPs that allow for reuse of the protective suits would give commanders more flexibility in mitigating risk while reducing the consumption of personal protective equipment.

“The BioTesting Division’s adaptation of their existing technique is a great example of the contributions made to the Army by the Combat Capabilities Development Command,” said Paul Tanenbaum, Ph.D., director of operational applications at the Center. “Our scientists and engineers create innovative, cross-disciplinary solutions, not only in materiel, but to support the TTPs and training, as well.”

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Sgt. Brittany Mattison performs decontamination procedures on Sgt. 1st Class William Anderson. Both Soldiers are assigned to the 690th CBRN Company, Alabama National Guard.
Working for the Warfighter
Engineering Driven, Warfighter Focused
By Chika Nzelibe

PROVIDING PRODUCTS FOR THE WARFIGHTER is the main focus for the Engineering Design and Analysis (ED&A) Branch, part of the Engineering Directorate’s Advanced Design and Manufacturing (ADM) Division at the U.S. Army’s Combat Capabilities Development Command (CCDC) Chemical Biological Center. ED&A uses a robust combination of engineering, physical science and computational design and analysis tools to provide solutions for the warfighter from concept through low-rate production. Working with the program offices and eliciting input from end users/warfighters, ED&A rapidly provides robust solutions for multiple products. Our team takes the lead on the design, integration and procurement as well as providing support for testing and validation efforts for projects to ensure the warfighter is thoroughly supported. Engineers have led multiple efforts within ED&A with the goal of providing best engineering driven warfighter focused solutions.

Within the past 24 months alone, engineers within ED&A have led multiple high-profile and innovative efforts to put products into the warfighters’ hands using engineering expertise and state-of-the-art tools.

The Analytical Laboratory Systems – Material Work Order (ALS-MWO) is for Joint Product Manager Chemical, Biological, Radiological, Nuclear and Explosives Analytics and Response Systems (JpD/M CBRNE A&RS). The ALS-MWO, a sophisticated mobile laboratory, allows the National Guard Bureau Civil Support Teams (NGB-CST) to respond to CBRNE (Chemical, Biological, Radiological, Nuclear and high-yield Explosive) incident sites with the ability to conduct identification and assessment of hazards, provide advice to civil authorities, and facilitate the arrival of follow-on military forces during emergencies and incidents. Our engineers led the design of the labs, integrated state-of-the-art technologies and coordinated procurement of the specialized scientific instruments and technologies. Now, the Center, in partnership with Pine Bluff Arsenal (PBA), will produce 66 ALS-MWO systems for the NGB-CST at PBA by 2022.

Dismounted Reconnaissance, Sets Kits and Outfits, Explosives Ordnance Demolition (DR SKO EOD) modified shipping containers are being done to support of Joint Project Manager for Nuclear, Biological, and Chemical Contamination Avoidance. DR SKO EOD provides the warfighter with the capability to protect against, detect and decontaminate chemical and biological warfare agents. The Center, in partnership with PBA, will produce 54 EOD systems by 2023.

The Colorimetric Reconnaissance Explosives Screening Set (CRESS) is a field test device that allows the warfighter to detect the presence of chemicals used for homemade explosives that have been encountered in improvised explosive devices (IEDs) across areas of operation. The CRESS is a handheld, single use and disposable detector that does not require a power source. Chemical reagents stored in glass ampoules produce color changes for specific identification of four analytes in either the liquid or solid state.

To support Array Configured of Remote Network Sensors (ACoRNS) sensor payload interface, ED&A is working with partner entities to develop modular capabilities for sensing hazards and autonomously operating unmanned vehicles such as the Detection Enhanced Experimental Platform (DEEP) Purple. Capabilities demonstrated in 2019 included detection, identification and collection of chemical vapors; and collection of chemical or biological aerosols using novel materials. The Center is currently developing version three of the interface to add capabilities and provide for smaller payload modules.

The Joint Program Executive Office for Chemical Biological Defense (JPEO-CBD) has tasked ED&A to support the Capabilities Enabling NBC (Nuclear Biological Chemical) Threat Awareness, Understanding and Response (CENTAUR) program. This includes design, procurement, fabrication, assembly, testing, shipping, and installation support of several Point Sensor Enclosure (PSE) systems under an Army Operational Needs Statement. The PSE is a stand-alone enclosure that is environmentally controlled to support several chemical and biological detection devices. The PSE is set up in a networked system such that several PSE’s are integrated and controlled remotely by one central command post. The Center will complete the latest phase of PSE development in September 2019.

ED&A offers in-house design and development capabilities that consistently lead to rapid solutions. Our team can take the lead on the design, integration and procurement as well as providing support for testing and validation efforts for projects to ensure the warfighter is thoroughly supported. The past 24 months have been busy, and we’re projecting even bigger efforts coming in the next few years.

As ED&A continues to engineer products and provide support to the warfighter, our goal continues to be to provide the best solution with the most advanced engineering tools available while reducing cost and schedule and increasing performance.
WHEN IT COMES TO TRAINING, REALISM IS A KEY COMPONENT to prepare Soldiers, Sailors, Airmen and Marines for the potential scenarios they may face during a mission.

The Army Futures Command’s focus on a synthetic training environment (STE) has provided more training resources to the warfighter than ever before, from augmented and virtual reality (AR/VR) to traditional training in a physical location. In some cases U.S. Army specialists require highly sophisticated training facilities due to their unique missions and highly hazardous work.

Fort Leonard Wood, Missouri, is home to the U.S. Army Chemical, Biological, Radiological and Nuclear (CBRN) School which owns the Department of Defense’s only live, toxic chemical warfare agent training facility offering realistic training scenarios to CBRN warfighters. Since the facility’s opening in 1999, the Chemical Defense Training Facility (CDTF) team has endeavored to create a more immersive training experience for warfighters resulting in greater knowledge retention, the development of muscle memory, and a reduction of fear by building trust in our military equipment – all goals of immersive training.

Several years ago, the CDTF Director crafted a vision for the context of the toxic training space which resulted in a new look and feel for the facility designed and visualized by the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center’s Advanced Design Manufacturing (ADM) facility.

The Center’s ADM facility specializes in a variety of industrial manufacturing capabilities including electronics, 3D printing and metalworking. For this project, ADM’s Interactive Software & Visual Media shop would support the CDTF’s vision due to their past experience in conceptual rendering.

Each year thousands of CBRN warfighters complete training at the CDTF, putting their skills to the test with actual toxic chemical agent. The CDTF also welcomes many international partners to complete the training. With advances in available technology, increased demands for training requirements and greater warfighter expectations, it became clear that it was time for a paradigm shift of the toxic training program at the CDTF.

"The U.S. Army’s move from counter-insurgency/terrorist threat-based training to large scale ground combat operations necessitated the retooling of our training program if we were to remain a relevant part of our national strategic CBRN enterprise readiness," CDTF Director Daniel Murray said. "As the Center of Excellence for CBRN defense within the Department of Defense, the redesign of the CDTF was essential to maintain our edge with regard to providing the most rigorous and challenging training possible in the area of Counter Weapons of Mass Destruction (C-CMWD) missions."

"Early on in design, we realized that misuse of forced perspective could cause trainees to experience distortions in the images as they walk through the space detracting from the realism," Lail explained. "Using virtual reality (VR), we were able to make design changes to correct the perspective issues we saw, walk around the space virtually, and then go back to the computer to make further refinements."

According to Don Lail, project lead for design, the context for each scene was based around real-life scenarios warfighters could find themselves in during a mission to address a chemical agent threat. Based on the story of each scene, the design team began the monumental task of researching geographic locations described for each room, diving deep into the minute details of what a crumbling building looks like after an explosion, the textures of rock, steel and glass, as well as perspective, which would pose one of the biggest hurdles to the team.

"Through research into current threats and a review of current intelligence data, we focused each target area on specific near-peer threats," Murray said. "The context of each target area helped drive the design and experience of each location."

Composite photography and 3D rendering were used to transform each target location from a seemingly simple brick and mortar room into a realistic, near-peer location warfighters may be deployed.

To combat the issues associated with perspective, walls were illustrated...
using a combination of orthographic projection (no main point of perspective) and single point perspective (gives the feeling of looking down a city street).

In addition to the expert design team, the Center leveraged its expertise as the nation’s leader in chemical and biological threat solutions to help the designers understand what a near-peer chemical production facility actually looks like. Through classified briefings from the Center, the design team was able to gain insight on the details necessary to really bring the scenes to life.

“We would have been at a loss had we not been a part of the Center,” Lail said.

With the design team in Maryland and the customer in Missouri it became apparent that regular image design reviews or even video conferencing reviews wouldn’t work, so the team decided to use virtual reality as the primary means of reviewing designs for the customer.

At each project milestone, virtual reality goggles were uploaded with the current version of each target location. CDTF leadership would don the goggles and tour each location virtually while on a conference call with the development team.

“The ADM team was incredible to work with,” said Joshua Schein, JPEO-CBRND project manager. “They were very responsive to our changes and consulted our team throughout the project to help us understand the impact our requested changes would make to the design.”

After several iterations, the end result is second to none in terms of realism and detail. Stepping into each target location, it’s difficult to sometimes tell where the physical boundaries of the room end due to the high resolution of the images. Many elements in the images were developed through 3D rendering tools like those used to enhance feature films with computer-generated imagery.

From crates and oil drums to Humvees and even a real subway train car, the attention to detail generates a convincing scenario environment.

Warfighters are immediately immersed in the location and the mission during their training session.

Each target is also packed with physical features and training aids to further enhance the training. From crates and oil drums to Humvees and even a real subway train car, the attention to detail creates a convincing scenario environment.

Murray has received a lot of positive feedback from both special operations and conventional units that have had the opportunity to use the facility.

“The comments have been consistent with regard to ‘these scenarios we can’t get anywhere but at the CDTF – they’re awesome!’” Murray added. “Those who have trained at the CDTF before and who now had the opportunity to train in the new scenarios were in awe of the realism and opportunity to get into such immersive and complex target sets.”

Specialty lighting and surround sound effects, such as urban bustle, gunfire, explosions and aircraft fly-bys were incorporated to further enhance immersion and realism.

Each target is also reconfigurable so all the physical fabrications can be moved around to suit customer desire.

“Humvees are on casters so they can be rolled into a different position in the room, boxes and other props can also be moved,” Lail said. “Even the signage can be changed to further obscure the threat or provide additional context in the training experience. Sometimes there may be no signage, other times signs might be in Chinese and another time they might be in English.”

Murray was impressed with the Center’s ability to interpret the CDTF’s requirements and deliver a product that exceeded expectations.

“Their innovative and far-reaching capabilities are simply astounding. Their work to bring our training space to life made the biggest impact on our finished product,” Murray said. “The CDTF is now the venue of choice for CBRN units world-wide as they seek opportunities to leverage capabilities replicated nowhere else in the world.”

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The Center’s custom wall graphics and attention to detail brought the CDTF to life, providing a more immersive training environment.

Photo provided by JPEO-CBRND

From crates and oil drums to Humvees and even a real subway train car, the attention to detail generates a convincing scenario environment.
Unique Team Handles Army’s Chemical and Biological Packaging
By Shawn Nesaw

READINESS IS THE U.S. ARMY’S TOP PRIORITY. For the U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center, readiness takes many forms, one of which is supporting the 20th Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) Command.

Recently, the Center, in collaboration with the Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense (JPEO-CBRND) and Pine Bluff Arsenal (PBA), embarked on an effort to provide consumable materials in a more reliable, organized way to support the 20th CBRNE Command.

Previously, the 20th CBRNE Command procured supplies through local purchases or supply systems which posed a host of issues for obtaining materials, the least of which meant competing with nationwide first responders for available inventory of highly advanced, limited quantity items. Warfighters would wait weeks, even months to receive some items.

The 20th CBRNE turned to the JPEO-CBRND for help in obtaining the equipment and commercial support products needed for the unit’s various missions. This request ultimately led to the effort, Countering Weapons of Mass Destruction (CWMD) Mission Configurable Loads (MCL). For support in this effort, JPEO-CBRND called upon the CCDC Chemical Biological Center and its proven record of excellence regarding military packaging.

Military packaging requirements are stringent. They require expertise to ensure not only the Army’s requirements are met but that items packed can withstand various modes of transportation in the military distribution systems, survive a wide range of storage time frames, stand up to varying environmental conditions, and can be accessed easily by the end user.

The Army relies on seven prepare-and-design activities to manage all its packaging and shipping needs. One of those seven activities is located at the Center. Known as the Packaging, Handling, Storage & Transportation (PHS&T) Branch, it’s the Army’s only prepare-and-design activity specializing in chemical and biological packaging.

The Devil is in the Details
Execution of the project was initiated, coordinated and managed by JPEO-CBRND but as of May 2019 Joint Product Leader for Rapid Acquisition, Integration and Fielding (JPL-RAIF) assumed the lead for the project. The project is being approached in four phases – planning, procurement, packing and shipping.

One of the key tasks conducted to get this effort started was to form an integrated product team (IPT) of pertinent stakeholders across the CBRN community. This IPT, in addition to personnel from the Center, PBA, and the 20th CBRNE Command, included representatives from the TACOM Lifecycle Management Command and the Defense Logistics Agency, among others.

Planning for the packaging, preparing load plans, and assembling technical data documentation were the key responsibilities of the Center’s team. Early on, warfighters from each 20th CBRNE unit listed the consumable materials they require for their unique missions based on their operational needs and shelf life. Once the lists were refined and agreed upon, the Center’s packaging specialists got to work scrubbing through the list of over 200 items to determine how exactly they would package everything.

While the team has plenty of advanced technology at their fingertips, their brainstorming started classically, on a chalk board. Sketches, calculations, ideas and more covered the 15-foot office chalk board from top to bottom.

‘Here is where we really figured things out from the ground up,’ Jorge Christian, packaging specialist said. “Once we got all our ideas down we started refining the concepts and were able to hone in on the best plan, making sure every item was not only accounted for but packed in a strategic way so the warfighter could access it easily.”

Items included everything from office supplies like pens and tape to specialized suits and hard-to-find technology. Each item was looked at from a variety of regulations to ensure it was packaged in the proper container and at the proper level in the container.

‘Personal protective equipment (PPE), worn by warfighters when chemical or biological agent threats are apparent, have inspection guidelines we had to consider when designing the load plans,” said Dexter Jennings, HAZMAT Certifier. “If we placed all the PPEs at the bottom of a container with other things that didn’t have inspection guidelines, a warfighter would have to dig through the container every time an inspection was scheduled. We made sure items with inspection guidelines were grouped and easy to access.”

One challenge the team faced was how to segregate HAZMAT items from non-HAZMAT...
items. Jennings managed the packing plans for all HAZMAT-related materials during the effort.

"Complying with regulations alone was a huge effort," Jennings said. "HAZMAT has a set of strict regulations we needed to adhere to. We identified, referenced and planned properly, then determined where they would fit into the larger load plans puzzle."

Once the team had their plans in place, Mike Holt, Center Engineering Drawing Development Branch chief, built out layered drawings called load plans from the biggest container to the smallest.

"The load plans show how each box is configured and gives the assembly team at PBA their guidebook for packing the containers properly," said David Vincitore, Center supervisory packaging specialist.

Once the plans were in place, it was up to the team to develop a clear and concise labeling system anyone could follow. "It's hard to say which stage of planning was more important than another but the label planning was up there," Vincitore said. "We're not going to be on the ground when these containers are unloaded from the trucks halfway around the world, so if we missed the mark on these labels, it would greatly impact all the hard work we put in elsewhere."

The labels had to be easy to read and interpret, and robust enough to handle environmental conditions when stored outside. To accomplish this, the team developed a labeling code consisting of numbers, letters and colors. Each element of the label, references a specific part of the container. Colors help minimize mix ups as well. All the green kits go together, for example.

Once the load plans were complete and approved, the team could assemble the baseline container set which would serve as a practice run to confirm the load plans and allow the team to make minor changes if necessary. The baseline also served as the example from which all other containers for each of the four teams would be based.

**Assembly**

As a designated joint service logistics center of excellence for CBRN, Pine Bluff Arsenal, Arkansas, was selected to complete the assembly piece of the effort.

Assembly of the crates depends on two major parts – procurement of all 200-plus items and physically assembling the containers with all the items designated for each unit.

To do this, once the baseline containers are complete, a team at PBA, led by project manager Jordan Freer, will assemble the containers specific to each unit, following the load plans to a tee.

"We'll take our time on the first few containers to make sure we work all the kinks out with the Center's team, but once the baseline is solid, we'll assemble the rest of the kits quickly," Freer said. "We have past performance experience with efforts similar to this. Due to that experience and our team's flexibility, we're able to confidently support the warfighter's needs."

The team is looking for ways to expedite parts of the assembly process through "pre-kitting."

"Some items from the list, like batteries, are easy to get so once we procure all the batteries on site per the load plans, we will package all the batteries accordingly and check batteries off the list," said Freer.

Pre-kitting could pose issues logistically so the team is careful how much pre-kitting they do.

"We're pre-kitting to a point," Christian said. "But what we won't do is send out partial containers to teams and then have to send additional shipments to complete the effort. That would defeat our entire plan in terms of ease of access and ease of use over time," Christian continued.

The timeline for completion of the effort is fluid for now as procurement of some items is a challenge.

"Some of the items like personal protection equipment suits, medical items and infrared chemical lights, are hard to come by or are on a production timeline by the company who produces them that doesn't mesh with our needs timeline," Vincitore said.

**Mission Support Readiness**

"Our team, both here at the Center and at PBA, are perfectly suited to support the mission," said Christian. "This is definitely a true team effort in which we work together with all the stakeholders to address the particular challenges of this project. Like so many things we do here, this effort has been a truly collaborative one. We have a unique capability that has been proven through the
years, to be effective in terms of packaging and design, but also defining the configurations which prove effective for future acquisition.”

The team has a track record that has been effective in competitive acquisition and in terms of sustainment.

“When this all goes according to plan, which we are confident with, and a client comes back asking for more kits, we’ll be the team that everyone leans on to get the job done right. We’re setting a precedent for future packaging efforts,” Christian said.

“This isn’t a one-shot-and-we’re-done type of project either,” Jennings said. “We are anticipating this effort is going to help sustain and facilitate future procurement of these kits.”

Those future efforts may also incorporate augmented reality (AR) into the mix, an area in which ADM is already at the forefront.

“The technical documents may be translated into an augmented reality program that allows the user to don AR glasses and navigate through the containers virtually,” Vincitore said.

The team hopes to have everything onsite at PBA this fall and aims to ship the first crates to warfighters a few months later.

Continued from page 23

CAREERS AT U.S. ARMY
COMBAT CAPABILITIES
DEVELOPMENT COMMAND
CHEMICAL BIOLOGICAL CENTER

The CCDC Chemical Biological Center offers exciting science and engineering career opportunities and is accepting applications from candidates who are working toward or have earned a bachelor’s, master’s or doctorate degree in the following fields:

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FOR ERIN DURKE, PH.D., a U.S. Army Combat Capabilities Development Command (CCDC) Chemical Biological Center In-house Laboratory Independent Research (ILIR) project turned out to be an international sensation. While attending her first International Conference on Aerosol Science and Technology in Prague, Czechia, in September, Durke won an award for outstanding work.

“I was really excited to showcase some of the fundamental work we are doing at the Center. Being acknowledged for it was just icing on the cake.”

Durke’s presentation, Characterization of Particle Charge from Aerosol Generation Process: Impact on Infrared Signatures and Material Reactivity focused on her research investigating the surface charge of aerosol particles.

“We study it in a more non-traditional way than most aerosol researchers,” Durke said. “We use transmission infrared spectroscopy, and we’ve been able to show differences in the spectra for powdered material versus aerosolized materials. We’ve also been able to use infrared spectroscopy to identify differences in the reactivity of the material as a function of aerosolization.”

As Durke mentions, many researchers remove or neutralize the charge on aerosol particles before characterization, however, the charge is present in real-world samples and likely has an effect on the physical and chemical properties of an aerosolized material.

In the battlefield, warfighters may come into contact with aerosols in a number of ways, perhaps via material that has been released from explosive munition or smoke canisters, for example.

“IT can drive a lot of the research and development that we do here at the Center, specifically when we are talking about aerosols,” Durke said.

Durke’s presentation won over approximately two dozen other presentations. She received a certificate to commemorate her win.
In the Community:

STEM Outreach Program Brings High-Tech Learning to Public Schools

By Brian B. Feeney, Ph.D.

BOTS FOR TOTS, MICROSCOPE DETECTIVE? These are just two of the new learning modules the CCDC Chemical Biological Center STEM Outreach Program is bringing to Pre-K through five classrooms in the Harford and Cecil County public schools.

These modules not only use thumb-sized robots and digital microscopes to introduce students to cutting-edge technology, they advance the learning objectives the schools draw from the Next Generation Science Standards which were developed by the U.S. Department of Education and National Academies of Sciences.

Building a Future Workforce

Ultimately, by building student enthusiasm for science, technology, engineering and math (STEM), the Center’s outreach efforts help build a new generation of science and engineering recruits for its vital national security role of conducting chemical and biological warfare defense research.

The Center has been actively promoting STEM learning in area public schools since the 1980s as an offshoot of the National Defense Education Program. Scientists and engineers from the Center regularly go to schools as guest lecturers, mentors, as judges for science competitions, and as exhibitors at science fairs and expos. In the last ten years, the Center has been providing learning-objectives-based educational experiences to students in the classroom at the invitation of teachers of all grades.

The Center’s STEM Program Manager, Casey Weininger, directs that effort, and his two newest modules, Bots for Tots and Microscope Detective, break new ground.

“With everything in our world becoming more cyber-oriented,” he explained, “I decided that getting kids interested in programming and coding at a young age would be a good way to prepare them for the future economy and for the Center’s needs in its future workforce.”

Bots for Tots

Weininger is developing a screen-free coding module centered around walnut-sized programmable robots called Ozobots. They make sounds, spin, and dance, and they are easily programmable by even very young children.

“Children in kindergarten and first grade can program the bots by drawing pathways using colored markers on white paper,” Weininger explained.

“The color sequence directs the bot’s movements, such as following a color-coded maze, so the kids get to see an immediate effect from their actions,” Weininger continued.

Students in higher grades can do more advanced programming with the bots using Android tablets and the bot’s built-in Bluetooth capability to wirelessly input instructions. The bots can be programmed to make sounds, flash lights, follow each other and avoid objects around them. Although only thumb-size, the bots are packed with technology and are an exciting way to introduce coding concepts to elementary school students.

Microscope Detective

A second new module Weininger designed for the 2019-20 school year is Microscope Detective. The Center purchased 10 inverted light microscopes with HD digital cameras that display a slide image under the microscope on a computer screen rather than squinting at it through an eyepiece. The students can observe cell structures in living things such as an onion skin or microorganisms in order to understand how those structures support the organism and function in the environment.

As the Center’s learning modules have grown in sophistication and evolved to closely match the curriculum needs of the schools, demand for class visits has increased.

“Within two weeks of the start of this school year I was booked solid for classroom appearances,” Weininger said. “That’s never happened before. And the variety of grade levels has increased, too. That means I’m getting some of the same students year after year, so my STEM teaching has continuity.”

Seeing an Impact

That continuity is having a real impact, too. The principal of Churchville Elementary School, Lisa Minutoli, told Weininger that because the Center’s STEM lessons, the students at that school have shown marked improvement in standardized tests in STEM subjects.

Weininger also finds himself contacted by school administrators who are pleased at the STEM Outreach Program’s embeddedness in their schools. Cecil County Public Library has discovered the program, too. “Many of these library branches serve groups of home schoolers which is a student demographic we’ve not been able to reach before,” Weininger said.

All this work adds up. Since just 2016, when Weininger began as the Center’s STEM Manager, the program has provided hands-on STEM learning experiences to more than 33,000 students in the 1,050 classes visited.

“Our outreach program will continue to spark student interest in STEM subjects at as early an age as possible by using fun technologies and encouraging student creativity. I hope to eventually see some of them at the Center as interns and ultimately full-time researchers.”

Inverted light microscopes with HD digital cameras can display images on a computer screen to reveal organic structures such as an onion skin as seen here.
Employee Spotlight: Terre Neil

TERRE NEIL IS AN INDUSTRIAL HYGIENIST with more than 13 years of experience working to minimize or eliminate potential health hazards and risks in the workplace. Throughout her career, her main goal has always been serving people. Solutions sat down with Neil recently to give readers an inside perspective on the role of an industrial hygienist and the role of the Center’s Safety and Health Office.

**Solutions Newsletter:** What influenced you to pursue a career in science?

**Terre Neil:** My parents always stressed the importance of an education and striving to do the best you can in whatever you do. When I was growing up, during our family dinners, my father would challenge me with math problems or we would discuss math or science-related topics. Our dinner conversations have been the genesis of my interest in math and science. My parents also taught me that it is important to learn something new every day, which is how I try to live my life. I’ve followed my passion for science and math and it’s provided some of the best experiences of my life.

**Solutions:** What is your role at the Center currently and how do you support the workforce?

**Neil:** As a member of the Safety and Health Office (SHO) I serve as the Center’s industrial hygienist (IH) and also fulfill a safety role. As the Center’s IH, I provide expertise to support the Center’s workforce and the Center’s supported missions. I support the workforce by developing and maintaining health and safety programs such as respiratory protection program, hearing conservation program, heat stress plan, and chemical hygiene plan. I also conduct traditional IH surveys including indoor air quality surveys, light surveys, ergonomic assessments, noise surveys, etc.

As a member of the Safety and Health Office, I also serve in a more traditional safety role albeit there are some similarities. I perform standard safety duties including SOP reviews, quarterly safety inspections, and contract reviews. During safety inspections, I’m looking for everything from tripping hazards to incorrect chemical storage and from housekeeping issues to blocked emergency equipment and expired chemical fume hood certifications. In addition, during the safety inspections I look for more IH-related issues such as indoor air quality or mold issues, ergonomic issues, potential hazardous noise exposures, and appropriate personal protective equipment selection, including respiratory protection. I also provide on-site safety support for chemical demilitarization sites, where I function as the on-site safety representative.

I serve as the recognized subject matter expert in industrial hygiene in the specialized areas supporting chemical and biological research, development, test and evaluation. I also provide professional-level technical guidance and consultation on IH matters including noise hazards and respiratory protection to the Center workforce.

**Solutions:** Explain what the Safety and Health Office does at the Center and how it benefits the workforce but also the Center’s overarching mission.

**Neil:** The Safety and Health Office is the Center’s resource for all things safety related. SHO implements the director’s safety program to ensure that it meets all Army, federal, state and local regulations. The staff prides itself on working with the employees to ensure that everyone returns home the same way they came to work. The SHO manages the Standard Operating Procedure Program, supports the chairperson of each Technical Guardian Committee, and provides answers to the day-to-day questions that the workforce has. SHO personnel can provide training and act as site safety and health Officers. SHO conducts internal inspections, but also helps prepare the Center for any external inspections for example the DA Inspector General, Defense Ammunition Center, Nuclear Regulatory Commission, and many others. As part of Risk Management, SHO also teams with the Environmental Quality and the Surety and Protection Offices to provide an all hazards approach in solving compliance issues and providing support to the directorates.

**Solutions:** Explain how science led you to working for the Center in your current capacity, as a scientist in a more non-traditional science role.

**Neil:** I assumed I would be working in a lab one day, but once I started taking college classes I realized that there are so many different careers, paths, directions that I could go with my education beyond bench lab work. I realized the importance of being open to opportunities to see where they would take me. I figured if I followed my passion for science and math, everything would fall into place. I believe it has.

**Solutions:** Are there any new ways the Safety and Health Office is planning to support the workforce in the future?

**Neil:** SHO just launched a new page on CBCConnect. We hope this assists the workforce in finding information easier. We are working to update the Technical Guardian Committee pages, too. This will allow the workforce to access even more safety information. We are reviewing processes that may be able to be streamlined and to not continue to do things just because that’s the way it was always done. We are always looking for suggestions on how we can improve our support to the workforce.

**Solutions:** What is a big accomplishment you’ve had while working at the Center that you’re particularly proud?

**Neil:** While I’ve received awards and acknowledgments for my work, I’m most proud of maintaining good communication and relationships around the Center and with many organizations. These relationships are invaluable in being able to accomplish safety/IH goals quickly and efficiently, and to answer some of the difficult health and safety questions that we are faced with from time to time.

**Solutions:** What unique or memorable opportunities have you had during your career supporting the Army?

**Neil:** I have had a few truly memorable opportunities I doubt I would have been fortunate to have if I wasn’t supporting the Army. As an IH at U.S. Army Public Health Center, while completing military housing inspections at Naval Station Mayport, I had the opportunity to try their helicopter full-motion/full-visual operational flight simulator used to train pilots.

On another occasion, I conducted a noise survey for the pilots at the airfield at Aberdeen Proving Ground. As a part of my survey, I was flown around in a helicopter to gather noise exposure data.

To support the 20th CBRNE Command and their mission, I traveled to Korea where I participated in the 8th Army’s Combined Joint Task Force for Elimination Exercise, providing my IH perspective to the plan risk assessment development.
DEVELOPING NEW TECHNOLOGIES TO BETTER PROTECT THE WARFIGHTER

from chemical and biological agents is a team effort. That’s why Christopher Karwacki, Ph.D., a CCDC Chemical Biological Center Principal Investigator, organized and hosted this year’s Defense Threat Reduction Agency (DTRA) Science Forum with funding and direction from DTRA on Sept. 17 and 18 at its Conference Center at Aberdeen Proving Ground.

The full name for the forum this year is the Surface Science of Filtration/Decontamination Materials and Multifunction Materials for Science Review.

The forum was first organized by the Center and DTRA in 2013 in recognition of the fact that the best science is done through active collaborations involving academia, national synchrotron facilities and DoD laboratories.

It began as a project review concentrating on adsorbent-catalyst technologies for enhancing warfighter protection and decontamination capabilities. Over time it expanded to include surface science and theoretical modeling to gain insight to the molecular dynamics of materials under battlefield conditions.

As it grew in scope, it evolved into a highly focused summit attended by less than a hundred researchers. This distinguishes it from DTRA’s annual Chemical and Biological Defense Science & Technology (CBD S&T) conference which covers the entire CBRNE research portfolio and is attended by more than a thousand researchers engaged in hundreds of research projects.

Attendees at this year’s forum came from the Center, other Army and DoD research laboratories, Brookhaven National Laboratory and research universities such as Harvard, Northwestern, Johns Hopkins, Virginia Tech, Rice, Emory, Stony Brook, Maryland and North Carolina. A key milestone this year is the establishment of the Defense Synchrotron Consortium (DSC) at the Brookhaven National Laboratory (BNL). The BNL-DSC will further enhance collaborations in materials research and surface science across DoD organizations.

The Center has seen some very successful collaborations begin at a DTRA Science forum. Karwacki first started discussions on multifunctional materials and surface science with research scientists from Emory University, Stony Brook University and Virginia Tech at an earlier forum. Through these discussions, the four researchers realized that they possessed the perfect compliment of skills to place reactive molecules on the surface of synthetically-produced metal organic frameworks (MOFs) so that chemical agent could be decomposed on the surface of the MOF rather than having it fully desorb.

Craig Hill, Ph.D., of Emory performed the synthesis of the molecules, Anatoly Frankel, Ph.D., of Stony Brook performed the synchrotron work, John Morris, Ph.D., of Virginia Tech performed the vacuum surface science, while Karwacki and Center scientists were responsible for the selection and design of the catalyst materials. The result was metal oxides and MOFs that could be bound to membranes and fibers. Their research efforts are now directed at creating a self-decontaminating suit for warfighters.

Discussions at the forum do not have to turn into joint research projects for them to have value. Monica Navin, Ph.D., said, “These forums have really helped me understand the practical needs of the warfighter. We can get pretty deep down into the science, so it’s important to always keep the warfighter in mind. Also, DTRA has a wide portfolio, even in just filtration and decontamination materials, so at these forums I get to see how my work fits into that broader effort.”

The forum attracts some of the leading lights in materials science. Naomi Halas, Ph.D., is a professor of biomedical engineering, chemistry, physics and astronomy. She is also director of the Laboratory for Nanophotonics at Rice University. She pioneered the creation of nanoshells, is author of more than 300 refereed publications, and has more than fifteen issued patents. Commenting on the vital role of the forum for advancing research to better protect the warfighter she said, “Research is more than just budgets and money. It thrives when researchers share their insights, ideas and approaches with each other, including what not to do. That saves time and money, making the cost of the forum pennies on every dollar saved.”
RESEARCHERS FROM THE U.S. ARMY
Combat Capabilities Development Command (CCDC) Chemical Biological Center met with warfighters and other stakeholders to showcase and garner feedback for emerging chemical and biological defense technologies during a training event at Camp Dawson, West Virginia Aug. 17-23.

The Chemical Biological Operational Analysis (CBOA), developed and executed by the Defense Threat Reduction Agency (DTRA), provided researchers an opportunity to elicit warfighter feedback during the technology development process. DTRA is responsible for managing and integrating the Department of Defense chemical and biological defense science and technology programs. According to the DTRA website, CBOA facilitates a collaborative working relationship between academia, government and industry and supports identification, assessment and dissemination of emerging and mature technology information and the acceleration of delivering capabilities to warfighters and those they support. Analysis results, provided to researchers after the event, are intended to aid and inform advanced technology development. The week-long event drew hundreds of scientists, engineers, warfighters and stakeholders to engage in meetings, discussions and demonstrations of emerging technologies.

"Feedback from the warfighter on developing technologies is like gold to researchers," said Eric Moore, Ph.D, director of the CCDC Chemical Biological Center. "It's very valuable and once obtained, can be a game changer. Any researcher developing warfighter-centric technology for the Department of Defense views warfighter feedback as one of the most important components in the development process."

The CCDC Chemical Biological Center showcased six technologies at CBOA with 26 subject matter experts in attendance as warfighters conducted simulated missions on Camp Dawson training grounds, putting some of the more mature technologies through their paces. After each mission, warfighters provided feedback to researchers which allowed for open discussions about each technology.

MinION, a commercial-off-the-shelf chemical and biological sequencing system, was one technology some warfighters carried during the simulated missions. "First, we're pleased with the durability of MinION which survived all three days of missions," said CCDC Chemical Biological Center researcher, Cory Bernhards, Ph.D. "It bounced around in a mini Pelican case every day but still worked and was able to complete its job."

Bernhards and his team have been refining sampling protocols for the MinION system, and were excited about how well MinION performed. "It sequenced a sample in just 35 minutes, which to our knowledge, has never been done," he said. "Usually sequencing takes approximately 24 hours."

"MinION's overall performance plus all the warfighter feedback we received during the hotwashes was invaluable to our team. We're really pleased with what we're heading home with," Bernhards said.

Another technology that received field time with warfighters during CBOA was the Full Spectrum Respiratory Protection System (FSRPS). Developed collaboratively by researchers at the CCDC Chemical Biological Center and Soldier Center, the backpack allows users to have extended operating time in comparison to the more widely known oxygen tanks used by firefighters. The team's approach provides users with two options for protection -- one setting filters air from the environment to the user while the other setting, a closed circuit system, provides recirculated air to the user, a higher level of protection. The FSRPS also provides cool air with both settings as well as a way to drink water while wearing the ensemble, two features unavailable with other similar suit systems.

Photos by Shawn Nesaw

Continued on page 29
Members of the 35th Civil Support Team, West Virginia National Guard, used the FSRPS system during the live demonstrations and provided feedback to researchers.

"Users liked being able to choose between breathing modes," said Jon Sampson, primary investigator at the Center. "Having the second option reduces the amount of time users experience higher breathing temperatures."

The team plans to conduct some additional research to improve the system overall, get more user feedback and influence potential future requirements.

In addition to the technologies tested by warfighters, Center personnel demonstrated five other developing technologies.

Aleksandr Miklos, Ph.D., demonstrated two technologies, paper on demand and VK3. Paper on demand prints mission-specific color changing paper chemical identifier tickets customized for specific chemical threats to reduce false positives and decrease operator burden.

VK3 is a field-deployable liquid chemical identifier that uses a built-in camera and computer to analyze an assay and identify the substance.

BioACER, a detection platform for biological agents, prevents the need for the warfighter to go into a contaminated area. Instead BioACER is delivered to the site in question by drone and sends feedback to warfighters who remain out of harm’s way. BioACER was showcased at CBOA by Cory Bernhards, Ph.D., Katherine Broadway, Ph.D., Phillip Mach, Ph.D., and Aleksandr Miklos, Ph.D.

A brand new technology brought to CBOA was the Pocket Detection Pouch (PDP), a field-forward self-contained, power-free sample collection and identification pouch for liquid and powder chemicals. The pouch has a small footprint, is lightweight and very easy to use. The pouches are customizable for the users’ needs, meaning different sampling papers can be included in the pouch. Designed and developed by Jennifer Sekowski, Ph.D., and Kelley Betts at the Center, the pouch is still a prototype, which is why CBOA was a great opportunity for the researchers to garner feedback on their idea early.

"We received a lot of positive feedback from warfighters about PDP," said Sekowski. "Form factor was appreciated by all as was the ease of use. We're coming away from CBOA with a clearer path forward to ensure what we develop meets warfighters needs."

Paper spray, an ambient ionization technique, uses a paper substrate to introduce ions into a field-portable mass spectrometer to detect chemical warfare agents from a wide variety of environmental mediums such as water, air and soil.

Using 3D printing, a CCDC Chemical Biological Center team designed and printed a more user-friendly paper spray delivery system using a cartridge form factor to contain the sample in question as well as an input system concept for the MX908 mass spectrometer.

"The concept is there, we just need to produce a working prototype pairing our input and cartridge system with the mass spectrometer," said Mach, a research biologist. "In speaking with the Army and Marines this week we received quality feedback about the form factor and usefulness of paper spray."

The CBOA event, while only in its second year, has proven instrumental in providing researchers supporting the DoD with quality feedback necessary to develop unique, warfighter-centric technologies that will modernize and elevate the nation’s armed forces.

During his morning address to the community of interest members on the final day of CBOA, DTRA Director for Chemical/Biological Technologies Ronald Hann, Ph.D., summed up CBOA and the mindset of everyone in attendance, “Through challenging the limits of technologies, we're all learning and trying new things for the benefit of the Soldier. We're doing the right things early for Soldiers.”
Look Who's Talking:

Every year, CCDC Chemical Biological Center personnel attend dozens of conferences and engagements across the country and around the world, sharing their expertise in the chemical biological defense space with stakeholders, community members, decision-makers and peers. The following list details many of the speaking engagements and presentations the workforce will participate in between October 2019 to December 2019.

<table>
<thead>
<tr>
<th>Conference Name</th>
<th>Topic</th>
<th>Location</th>
<th>Date(s)</th>
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<tbody>
<tr>
<td>SCIX 2019, The Great Scientific Exchange</td>
<td>Standoff Chemical and Explosive Detection of Military Relevant Threats</td>
<td>Palm Springs, CA</td>
<td>13-17 October 2019</td>
</tr>
<tr>
<td>Chemistry 2019</td>
<td>Advancements in Colorimetric Detection Capabilities of Chemical Threat Agents</td>
<td>Rome, ITALY</td>
<td>21-26 October 2019</td>
</tr>
<tr>
<td>NIOSH Confirmatory Assessment Meeting</td>
<td>Chemical Biological Center capabilities brief</td>
<td>Pittsburgh, PA</td>
<td>29 October 2019</td>
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<tr>
<td>SETAC North America 40th Annual Meeting</td>
<td>Reproduction Toxicity of Insensitive Munitions Compounds for Soil Invertebrates</td>
<td>Toronto, Ontario, CANADA</td>
<td>2-8 November 2019</td>
</tr>
<tr>
<td>2019 CBRNe Convergence</td>
<td>Refinery and Chemical Industry Emissions Symposium</td>
<td>Davis, CA</td>
<td>5-9 November 2019</td>
</tr>
<tr>
<td>19th Annual Diabetes Technology Meeting</td>
<td>Harvesting and Assaying ISF Using Microneedles</td>
<td>Rockville, MD</td>
<td>13-16 November 2019</td>
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</tbody>
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Conference Name: 2019 EPA International Decontamination R&D Conference
Topic: Decontaminant Reactivity Screen with Select Fentanyl
Location: Norfolk, VA
Date(s): 19-21 November 2019

Conference Name: Inaugural US Cell-Free Systems Conference
Location: Boston, MA
Date(s): 4-6 December 2019

LET'S COLLABORATE!

We offer a wide range of chemical biological expertise, cutting-edge facilities and innovative technology solutions to our partners.

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**Publications and Patents:**

**QUARTERLY LISTING**

This page contains the peer-reviewed journal articles recently published on research conducted by Center scientists and U.S. patents recently awarded to the Center between April 2019 and June 2019.

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**PUBLICATIONS**

(CCDC Chemical Biological Center authors in bold)

**Title:** Proteomic Characterization of Immunoglobulin Content in Dermal Interstitial Fluid  
**Author(s):** Arevalo, MT; Rizzo, GM; Polsky, R; Glaros, T; Mach, PM  
**Source:** JOURNAL OF PROTEOME RESEARCH  
**Volume:** 18 **Issue:** 6 **Pages:** 2381-2384  
**DOI:** 10.1021/acs.jproteome.9b00155 **Published:** June 2019

**Title:** Disordered Mesoporous Zirconium (Hyd)oxides for Decomposition of Dimethyl Chlorophosphate  
**Author(s):** Colon-Ortiz, J; Landers, JM; Gordon, WO; Balboa, A; Karwacki, CJ; Neimark, AV  
**Source:** ACS APPLIED MATERIALS & INTERFACES  
**Volume:** 11 **Issue:** 19 **Pages:** 17931-17939  
**DOI:** 10.1021/acsami.9b00843 **Published:** May 15, 2019

**Title:** Correlated Multimodal Approach Reveals Key Details of Nerve-Agent Decomposition by Single-Site Zr-Based Polyoxometalates  
**Author(s):** Tian, YY; Plonka, AM; Ebrahim, AM; Palomino, RM; Senanayake, SD; Balboa, A; Gordon, WO; Troya, D; Musaev, DG; Morris, JR; Mitchell, MB; Collins-Wildman, DL; Hill, CL; Frenkel, AI  
**Source:** JOURNAL OF PHYSICAL CHEMISTRY LETTERS  
**Volume:** 10 **Issue:** 9 **Pages:** 2295-2299  
**DOI:** 10.1021/acs.jpclett.9b01002 **Published:** May 2, 2019

**Title:** Synthesis and Molecular Properties of Nerve Agent Reactivator HLo-7 Dimethanesulfonate  
**Author(s):** Hsu, FL; Bae, SY; McGuire, J; Anderson, DR; Bester, SM; Height, JJ; Pegan, SD; Walz, AJ  
**Source:** ACS MEDICINAL CHEMISTRY LETTERS  
**Volume:** 10 **Issue:** 9 **Pages:** 2295-2299  
**DOI:** 10.1021/acsmedchemlett.9b00021 **Published:** May 2, 2019

**Title:** Scalable, Room temperature, and Water-Based Synthesis of Functionalized Zirconium-Based Metal-Organic Frameworks for Toxic Chemical Removal  
**Author(s):** Chen, ZJ; Wang, XJ; Noh, H; Ayoub, G; Peterson, GW; Buru, CT; Islamoglu, T; Farha, OK  
**Source:** CRYSTENGCOMM  
**Volume:** 21 **Issue:** 14 **Pages:** 2409-2415  
**DOI:** 10.1039/c9ce00213h **Published:** April 14, 2019

**Title:** Carboxylic Anchoring Dye p-Ethyl Red Does Not Adsorb Directly onto TiO2 Particles in Protic Solvents  
**Author(s):** Fang, H; Ma, JQ; Wilhelm, MJ; Rao, Y; Kuhn, DL; Zander, Z; DeLacy, BG; Dai, HL  
**Source:** JOURNAL OF PHYSICAL CHEMISTRY C  
**Volume:** 123 **Issue:** 13 **Special Issue:** SI **Pages:** 8265-8272  
**DOI:** 10.1021/acs.jpcc.8b08513 **Published:** April 4, 2019

**PATENTS**

**Process for Decontamination and Detoxification with Zirconium Hydroxide-Based Slurry**  
**Patent Number:** 10,245,456  
**Issued:** April 2, 2019

**Engineered Organophosphorus Acid Anhydrolases and Methods of Use Thereof**  
**Patent Number:** 10,260,054  
**Issued:** April 16, 2019

**Self-Indicating Zirconium Hydroxide and Other Porous Metal Hydroxides Incorporating Additional Metals, Metal Oxides, and/or Metal Salts for Toxic Chemical Removal and Sensing**  
**Patent Number:** 10,261,022  
**Issued:** April 16, 2019

**Mutant OPAA Enzyme with Increased Catalytic Efficiency on Organophosphorus Compound GP**  
**Patent Number:** 10,335,465  
**Issued:** July 2, 2019

**Mutant OPAA Enzyme with Increased Catalytic Efficiency on GP**  
**Patent Number:** 10,363,289  
**Issued:** July 30, 2019

**Sampling and Detection Kit for Chemical and Biological Materials**  
**Patent Number:** 10,408,809  
**Issued:** September 10, 2019

**Mutant Organophosphorus Acid Anhydrolase Enzymes Having Increased Catalytic Efficiency on V-Agents**  
**Patent Number:** 10,421,952  
**Issued:** September 24, 2019
Send article suggestions, questions or comments to:
CCDC Chemical Biological Center Public Affairs Officer Richard Arndt at richard.m.arndt.civ@mail.mil.

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