ARMY TECHNOLOGY

MAY/JUNE 2015 | VOLUME 3, ISSUE 3

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FOCUS: FUTURE COMPUTING

+PLUS

INTERVIEW WITH

DR. JOHN PELLEGRINO

U.S. ARMY RESEARCH LABORATORY

MAY/JUNE 2015 | VOLUME 3, ISSUE 3

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ACRONYM GUIDE

AMC	U.S. Army Materiel Command
RDECOM	U.S. Army Research, Development and Engineering Command
ARL	Army Research Laboratory
ARDEC	Armament Research, Development and Engineering Center
AMRDEC	Aviation and Missile Research, Development and Engineering Center
CERDEC	Communications-Electronics Research, Development and Engineering Center
ECBC	Edgewood Chemical Biological Center
NSRDEC	Natick Soldier Research, Development and Engineering Center
TARDEC	Tank Automotive Research, Development and Engineering Center
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
ARCIC	Army Capabilities Integration Center
DARPA	Defense Advanced Research Projects Agency
DASA(R&T)	Deputy Assistant Secretary of the Army for Research and Technology
USC ICT	University of Southern California Institute for Creative Technologies
DSRC	Defense Supercomputing Resource Center

RDECOM Commanding General Maj. Gen. John F. Wharton speaks at the U.S. Army Warrior's Corner during Association of the United States Army Global Symposium and Exposition April 1, at Huntsville, Alabama. The general also appeared on the "S&T Driving Innovation for the Force 2025 and Beyond" panel. (U.S. Army photo by Kelly DeWitt)

On the cover: *Dr. Tad Brunyé guides a Soldier participating in a navigation virtual reality exercise at the Natick Soldier Research, Development and Engineering Center. Brunye, who is on the Natick Cognitive Science Team, is investigating various influences on choices people make when choosing a route.*
Front cover *photo by David Kamm*
Back cover *design by Joe Stephens with photo by Tom Faulkner*

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Envisioning the Future of Computing

By Maj. Gen. John F. Wharton, Commanding General
U.S. Army Research, Development and Engineering Command

Maj. Gen. John F. Wharton
Commanding General
RDECOM

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

As we invest in a future where technology will lighten the load and better protect Soldiers, we look to scientists and engineers from across the U.S. Army Research, Development and Engineering Command and ask, "What decisive capabilities will future computing bring for unified land operations to empower the Army, the joint warfighter and our nation?"

With advanced computers, the U.S. Army continues to see improvements and efficiencies. But where will we be in 10 years?

Looking to the past may provide some clues. In 1976, the world's most powerful computer was the Cray-1 supercomputer installed at Los Alamos National Laboratory. The massive machine weighed 11,000 pounds.

Today's common laptop computer is more than 1,000 times more powerful and, thankfully, a lot lighter.

> "Our goal is not to replace Soldiers, but provide a continuum of capabilities that will augment and enable them."
> – **Maj. Gen. John F. Wharton**

I believe the future holds amazing potential. Through our partnership with the University of Southern California Institute for Creative Technologies, we are advancing research in computer-generated characters that use language, have appropriate gestures, show emotion and react to verbal and non-verbal stimuli. This "virtual human" effort has applications in training and education and, hopefully, intelligent agents and robots as well.

Imagine a Soldier of the future holding a conversation with a computing device or robot that has vast situational awareness, connectivity and resources. We look to future computers to communicate more effectively by processing natural language and advancing how we interact with machines.

As individual technologies mature and gain acceptance, autonomy is evolving layer-by-layer. Vehicles will eventually drive themselves. In the far future, we envision robots and autonomous vehicles as integral members of the team. This means advanced computing will play an even greater role in keeping our Soldiers safe.

Our goal is not to replace Soldiers, but provide a continuum of capabilities that will augment and enable them, while meeting some of the Army's most challenging capability requirements.

Future software development will enable our systems, vehicles and devices to build on a common architecture that will foster compatibility and modular upgrades. Hardware is also improving at an exponential rate. These developments help with the bottom line.

In a resource-constrained future, training dollars are more precious. Advanced computer simulations will provide realistic training at a fraction of the cost. Additionally computer modeling and simulations provide our scientists and researchers with invaluable tools to predict how equipment will react in a myriad of environments.

Future lethality with enhanced computing need only be as lethal as necessary to accomplish the mission. As our advanced sensors, targeting and associated technologies match our improvements in lethality, commanders will have fine-grained control to minimize, if not completely avoid, collateral damage.

The Army has global responsibilities that require technological advantages to prevail decisively in combat. This is what Gen. Raymond Odierno, the Chief of Staff of the Army, has called "technological overmatch."

At RDECOM, the search for technological overmatch is in our DNA. Within our core competencies, we find full-spectrum innovation to meet the goals of the Army of 2025 and beyond. I am inspired by the ground-breaking research and development that occurs at our centers and labs. Army Strong!

ARMY TECHNOLOGY

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Limitless Potential of Future Computing

INTERVIEW WITH THE U.S. ARMY RESEARCH LABORATORY'S DR. JOHN PELLEGRINO

Dr. John Pellegrino is the director of the Computational and Information Sciences Directorate and chief information officer for the U.S. Army Research Laboratory.

He is responsible for basic and applied research and its transition in the areas of network and information sciences, cyber defense, high-performance computing and technology for battlefield environments. His duties include research program development and coordination, technology transition and support to current forces, as well as responsibility for laboratory network operations. He has technical oversight of the state-of-the-art high performance computing assets, computational capabilities, and wide area networking methodologies for the laboratory, Department of the Army, and DOD; as well as oversight of the DOD Major Shared Resource Center at ARL and the U.S. Army Research Laboratory Defense Supercomputing Resource Center.

Pellegrino earned a bachelor of arts in physics from Gordon College in 1976, a master of science in physics from University of Wisconsin-Madison in 1980 and completed his doctorate from the University of Wisconsin-Madison in 1981.

He has authored and co-authored more than two dozen technical papers and reports, and is co-editor of the book "Accousto-Optic Signal Processing."

Army Technology: What is your vision for the future of computing?

Pellegrino: We've barely begun to scratch the surface of what's possible with computing.

We see the future of computing continuing down two paths. One, to be the big iron computing, or the massive computing architectures and machines. It is massively parallel and incorporates new kinds of algorithms. It's enabling us to do things like design new munitions and design new materials from scratch.

We're just beginning to see how to do modeling of materials so we can have control over every stage of the development and therefore come up with totally new classes of ultra-lightweight and ultra-strong materials for armor or new kinds of electronics for example.

As we march forward, we're going to be tackling big problems in networks. What is a composite network? How does the Internet work? How are we going to be able to protect it, and extract information from it? That's one whole train of research in computing and application of computing that will be going on.

We have only a vague idea at this time how to protect that information. Cyber-defense is a big issue. The communications, even protecting parts of the communication, how information is connected, how to keep communications robust even in the face of heavy adversarial action … it's a big deal.

On the other side, it's the embedded computing that will be in just about everything. We see these things going in a trajectory to be more and more powerful, but to be more embedded and integral with things.

One of the futures of computing that many of us see is that extremely interesting space of the intersection with the human and the computer. The human originality, creativity, the spark, will benefit from the augmentation of more mundane things to really enable that creativity and foster and let it grow without having to worry about the ordinary porting around stuff.

Army Technology: How will modeling and simulation spark innovation?

Pellegrino: As we do modeling and simulation, it's revealing new kinds of material properties in elasticity, strength and ruggedness. We see how we can exploit this and design materials to exploit this.

It's the modeling and the interaction with the models that enables the human, in this case, the scientist and engineer, to get in there and play with all the parameters and see what difference they make. Those kind of simulations used to take us days, or weeks to run. Now we're able to run certain types of routines in minutes.

It's the interaction between scientists and engineers with that model, or with that simulation that enable him to go back, re-adjust parameters and discover new properties.

Army Technology: Will computer advances hit a technological barrier?

Pellegrino: It's funny because predictions of the demise of Moore's Law [the idea that overall processing power for computers doubles every two years] have been there for about every five years for the past 30. Every time, something comes along, which enables us to jump over Moore's Law.

At present, the latest barriers down at the sub tens of nanometer scale [a nanometer is 1/25,000th of a meter] are being surpassed with the introduction of three-dimensional technology. We're going into the third dimension with interconnections and building up. When I talk up, I'm still talking on the nanoscales.

There are other approaches including quantum computing processing that will be good for special kinds of problems. If you can look at algorithms that have heavy factorization in them, then that is a kind of computing approach that will work or that may work for that.

I don't see in any kind of near- to mid-term a lessoning of the increase in computing power. I think that will keep marching on and keep getting smaller integrated circuits. I think the bigger challenge is going to be how these pieces all relate, how we protect them and how we use them for the Soldier.

Army Technology: Where will artificial intelligence take us?

Pellegrino: This is a matter of some debate. A computer can compute things faster. It can run through a whole set of variables faster. In the future, we'll be able to take massive amounts of data and draw new and interesting correlations between them. That kind of data integration may and will give new insights into science and interpretations, but the human still provides that spark of insight that would enable somebody like Einstein to come up with the Theory of Relativity. Humans ask those questions. Computers crunch tons of variables. Humans have insight into meaningful ways to look at this, or say, "Wow! I never thought of looking at it that way."

Personally I think it will be a long time before we will get to the point where we can call what comes out of a computational architecture, if you will, truly creative.

Army Technology: How does the Army partner with industry and academia?

Pellegrino: In the information technology space, including computers, the information processing and the interaction with humans, we have a very extensive partnership with the private sector. The technology is moving at an enormous rate, and they're driving many great innovations.

We have a great partnership with academia and industry, including leaders in the area such as Raytheon BBN, and IBM; universities from Stanford, Carnegie Mellon and Penn State, and others too numerous to mention.

We do great collaborative joint research in the area where our scientists and engineers bring their unique understanding of science and the kind of problems that the military faces together with the innovations that are occurring in universities. It makes for an extremely strong partnership and a very dynamic research environment.

Army Technology: How will ARL's campaign plan provide new capabilities?

Pellegrino: ARL has embarked on defining key areas for the laboratory, for the Army and for the future. We have gone through and done a delineation of the kind of issues that are important to us. Within the information science campaign we talk about taming the flash floods of information on the battlefield and how a Soldier will interact with it. In the computational sciences, we've talked about predictive simulations and the future of tactical battlefield computing.

You look at the blending of those things together with how the human, in our case the human Soldier will interact with those. It sets a very rich field for inquiry.

Then, we can address some of the key problems facing our Soldiers on the battlefield as they encounter adversaries that are extremely powerful in terms of their communications and information access skills.

Army Technology: How optimistic are you about future computing?

Pellegrino: There is almost limitless potential out there. We're doing some really fascinating work from modeling and simulation of materials by design from the atom all the way up to the interaction of humans and information and hardware—whether that be robotics or information systems embodied in chips—that will enable the Soldier to be very highly instrumented and capable and have more information and access at their fingertips than ever before.

We can envision a future where a Soldier, who right now potentially carries 75 to 100 pounds on his or her back for a mission loaded with batteries, sensors and communications tools, to be free of a lot of that. They may have a robotic companion. They may have more access to localized computational assets. They may not have to, for example, carry a rifle because they will be able to do targeting and identification of things and ask the right questions all from organically emplaced computational assets.

In the not-too-far future, we are going to have much more computational capacity on our persons.

From a medical standpoint, if you look at ficitional super heroes, The Flash, or Iron Man—either one, they have a whole bunch of sensors embedded on them that gives every little bit of their medical state and can deliver whatever is needed and appropriate to both enhance their performance and keep them safe and healthy. That's what we look for, a very highly effective, highly empowered Soldier that is safe, healthy and has what they need to do the job.

For more on Limitless Potential of Future Computing: ***https://youtu.be/k3IggbDw-aM***

STAND-TO!

THE OFFICIAL FOCUS OF THE U.S. ARMY

Army Cloud Computing Strategy

WHAT IS IT?

The Army Cloud Computing Strategy sets the strategic direction and guidance to posture the Army for maintaining a secure operating environment while transitioning the Army's information technology infrastructure, systems, software and application platforms; data assets; and related business processes and practices. It is the overarching plan for the transition to cloud-based solutions.

The Army Cloud Computing Strategy is designed to establish and communicate the Army's vision and strategy for transitioning to a cloud-enabled network, to improve mission and business effectiveness, increase operational IT efficiencies and protect Army data and infrastructure. The strategy extends the baseline and concepts defined in the various federal, DOD and Army documents to meet specific Army requirements.

WHAT HAS THE ARMY DONE?

The Army is changing its approach to modernizing IT infrastructure by moving to a cloud based methodology. This approach emphasizes reducing IT hardware procurements and sustainment in favor of procuring these capabilities as services from cloud service providers.

WHY IS THIS IMPORTANT TO THE ARMY?

Cloud technology has great utility for the military. Cloud computing will increase the capabilities and responsiveness of both the generating and operating forces globally during Joint operational phases whether preparing to deploy in the installation IT environment, en route or engaged as part of a Joint force in a theater of operations. Cloud infrastructure, people and processes will be central to enabling the Joint Information Environment. The ability to connect to cloud capabilities assures availability, accessibility and security of Army computing and communications resources, authoritative data sources and information from the enterprise to the point of need.

Transitioning to cloud-based solutions and services advances the Army's long-term objective to reduce the ownership, operation and sustainment of hardware and other commoditized IT. Procuring these as services will allow the Army to focus resources more effectively to meet evolving mission needs. Over time it will significantly boost IT operational efficiency, increase network security, improve interoperability with mission partners, and posture the Army to adopt innovative technology more quickly at lower cost.

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

The Army will implement modernization plans and develop processes and procedures to leverage approved DOD, federal and commercial cloud service providers, and ensure offerings align to mission requirements and provide the minimum set of security controls necessary to protect critical information against known and emerging threats. The transition to cloud-based solutions and services will enable the Army to successfully provide the robust network necessary for the warfighters anytime, anywhere.

FOCUS QUOTE

"In support of a globally responsive and regionally aligned force, the Army is working with key mission partners to implement a cloud-based network ... The Army's Cloud Computing Strategy and the Army's Network Campaign Plan ... outline efforts that posture the Army for success in a complex world."

— **Lt. Gen. Robert S. Ferrell, Army Chief Information Officer/G-6**

For more on Army Cloud Computing Strategy : ***http://www.army.mil/standto/archive_2015-03-26/***

REVOLUTIONIZING SOLDIER COMMUNICATION

Harnessing the brain-computer interface

BY JENNA BRADY, ARL PUBLIC AFFAIRS

What if you could communicate through your computer or phone without making a sound or moving a single muscle?

Scientists at the U.S. Army Research Laboratory are investigating this very concept, which has the potential to revolutionize both medical applications and the way in which Soldiers communicate on the battlefield.

The science behind this idea is known as Brain-Computer Interface, or BCI, aims to create technologies for recording brain activity and establishing computational methods and algorithms to translate the signals into computer executable commands.

BCI has been most commonly used with individuals who are paralyzed and cannot move or communicate verbally due to paralysis of nearly all voluntary muscles in the body, with the exception of their eyes.

As a result of recent advances in hardware and software, coupled with breakthroughs in neuroscience and cognitive science, these individuals are able to perform functions such as typing letters, writing emails, making phone calls and controlling a robotic arm, solely by thinking.

There are several different methods of recording brain activity for BCI that allow the above-mentioned functions to be accomplished, but two are most common in BCI research.

The first is noninvasive, where electroencephalography, or EEG, devices record electrical activities of the brain along the scalp using an array of electrodes placed on the scalp. The second method involves more invasive techniques, where electrocorticography, referred to as ECoG, devices record electrical activities from the cerebral cortex of the brain using electrodes placed directly on the exposed surface of the brain.

While the ability to perform these tasks is a great milestone in and of itself, current BCI techniques have been found to only be successful in laboratory settings. In addition, current BCI techniques require extended training and are not practical for ordinary daily lives.

"ARL recognizes that BCI is an emerging area with a high potential for revolutionizing the way we communicate with machines and that the potential exists for larger scale real-world applications such as brain-based communication through everyday devices," said Dr. Liyi Dai, program manager in the Computer Sciences Division at ARL's Army Research Office located in Research Triangle Park, North Carolina.

According to Dai, ARL has established multi-million dollar, multi-year efforts consisting of teams of university researchers from schools, including Albany Medical College and the University of California, Irvine, equipped with multidisciplinary expertise drawn from computer science, mathematics and neuroscience.

These investments focus on two main challenges of BCI technology. The first is that current underlying algorithms are not reliable enough to perform well under a wide range of operation environments and conditions for real-world applications.

"ARL/ARO investments have been focused on creating advanced computation algorithms so that, with the new algorithms, BCI capabilities are moving a step closer toward real applications. The new algorithms

Noninvasive electroencephalography based brain-computer interface enables direct brain-computer communication for training. (U.S. Army photo)

put greater emphasis on the dynamics of brain signals and the interaction of different parts of the brain," Dai said.

The second challenge is that current BCI techniques do not include a feedback mechanism to help operators understand why a certain function did or did not occur based on their thinking process.

"Another way to increase BCI performance is the inclusion of a feedback mechanism, that is, the human operator adjusts the way of thinking in response to the outcome of the underlying detection algorithms," Dai said.

For example, if the operator of a BCI capable device is unsuccessful in performing a certain task, he or she will be given feedback to "think harder" to strengthen his or her brain signals to be able to perform that task.

ARL/ARO investments have also led to new capabilities including the detection of imagined speech, or thinking silently to oneself, and attention.

In 2008, ARO's Information Processing and Fusion Program and Neurophysiology and Cognitive Neuroscience Program jointly established a major research initiative under the Multidisciplinary University Research Initiative program.

Two projects are currently funded under this initiative.

One project, entitled "A Brain-Based Communication and Orientation System," works on developing a prototype system for detecting imagined speech and monitoring user's attention and orientation using recordings of brain activities in real time.

The second project, entitled "Silent Spatialized Communication among Dispersed Forces," focuses on understanding physiological biomarkers of brain signals for imagined speech detection, which provides biological basis toward designing computational algorithms to extract biomarkers, or features, for imagined speech detection.

"The ARO MURI projects were the first major investments to address the basic research challenge of signal processing and pattern classification for imagined speech and attention detection. The efforts have successfully demonstrated the feasibility of imagined speech detection using ECoG or EEG, which has led to increased interest among the academic community on this subject," Dai said.

One major achievement that was made through these projects is that ARL/ARO research revealed for the first time that different brain regions are involved in producing vowels and consonants.

Just as in the establishment of other disruptive technologies, it may take many years or even decades to mature BCI technology, but Dai and his fellow researchers are confident that further progress means potentially great capabilities for our Soldiers.

"Progress in BCI based communication is potentially of great importance to the warfighter because BCIs would eliminate the intermediate steps required in traditional human-machine interfaces. Having a Soldier gain the ability to communicate without any overt movement would be invaluable both in the battlefield as well as in combat casualty care," Dai said.

Dai added that BCI communication would provide a revolutionary technology for silent communication and orientation that is inherently immune to external environmental distraction such as sound and light.

Evolution of this research could lead to direct mental control of military systems by thought alone.

Imagined speech detection is also said to have potential medical applications in speech therapy and epilepsy treatment, as the research provides complementary understanding of brain activities for speech, an important part of human capabilities.

Moving forward, Dai noted that substantial individualized experimentation is required to train the underlying algorithms, and further improvements of computing algorithms are needed toward robust brain signal processing and analysis to achieve reliable BCI performance for a wide range of practical applications.

Amidst the challenges faced in BCI research and the progress to still be made, scientists are working hard behind the scenes to bring this technology to fruition and make it applicable in real-world situations for the benefit and protection of our Soldiers. ■

COMPUTERS HARNESS LANGUAGE TRANSLATION

Medical providers find unique uses for computer technologies

BY JOYCE P. BRAYBOY, ARL PUBLIC AFFAIRS

While leading a medical training team in Kabul, Afghanistan, a U.S. Navy commander became frustrated as he faced the challenge of interpreting complex medical information.

Commander Kurt Henry was seeing cases of intestinal tuberculosis that he knew were treatable, but the regional hospital's critical care unit did not have medical manuals to provide treatment instruction for newly assigned doctors.

When he scanned the Internet for documentation about treatment options, he only came across information written in English. His team spoke the native language of the Afghan people, Dari, recalled Steve LaRocca, computer scientist and team chief at the U.S. Army Research Laboratory.

Now, almost seven years later, the situation is better for medical trainers because of statistical machine translation methods that cut down on the Army's reliance on human translators in projects that require massive amounts of translation.

By early 2012, ARL had provided 500 printed English-Dari special trainers' editions of the critical care reference manual to doctors in hospitals and clinics throughout Afghanistan to meet the need for medical teams like Henry's.

More and different manuals have since been translated, printed and shipped, and another priority translation is currently nearing completion.

ARL computer scientists and the newly assigned Afghan doctors have carefully translated and collected more than 6,000 Dari medical phrases over the course of the initial project.

Secondary products, including an Android "Army Phrase Book" app, have been developed to make broader use of the expertise captured in the translated phrases.

Forward Operating Base Lightning, near Gardez, Afghanistan, received critical care manuals with Dari/English translations made possible by U.S. Army Research Laboratory translation technology. (U.S. Army photo)

Without computational support, translators would speak into a recorder for an hour to extract small bits of data, LaRocca said.

"The challenge was working with a limited pool of potential translators who were familiar with Dari, a less commonly taught language; and who also understood medical jargon," LaRocca said.

Speech recognition technology was LaRocca's specialty when he retired from West Point as a language professor and founding director for the Center for Technology Enhanced Language Learning in 2004.

LaRocca advised military leaders on getting the most from limited translation resources, when he wore the uniform, with the understanding that "there is no way our language-qualified people could give all the capacity we need in theater."

At ARL, his team explores ways to harness the knowledge of linguists by capturing hundreds of hours of translations stored in databases where the translated sentences could be shared and reused.

The laboratory applies statistical machine translation methods to specialized Army problems where there is not a commercially available solution, said Melissa Holland, chief for ARL's multi-lingual computing research program.

"Computers could never replace the human translator, but we look for ways to relieve some of the burden, especially in less commonly used languages, like Dari, Pashto and Serbian," Holland said.

The multilingual computing group addresses challenges with medical, and also legal and Army training translations, she said. The information used in translating the medical phrases is kept in a database for use across the Defense community.

Computer translation breakthroughs in the last decade, along with the Dari datasets, greatly reduced the projects' dependence on the small number of bilingual human translators, and who are also subject matter experts. Computers remember and reuse expert knowledge.

"We've had people translating every day in Korea since about 1951, but we didn't save the datasets over those decades," LaRocca said. "The knowledge generated by all those people over all those years is gone."

He said, "If we had the presence of mind to curate that data or prepare it for the eventual use of technology, we would be so much better off in that language and many others."

LaRocca embraced the idea of capturing and saving datasets from projects in the Dari and Pashto languages.

He is not the only one. Lt. Col. Forest Kim led a team of medical advisors under the surgeon general in Afghanistan from November 2013 to May 2014. His team had seven language translators, but he said there is not enough time or assets to translate large volumes of text.

His team circulated discs and DVDs to train medical trainers in the region.

"We were making a lot of changes, but I knew we were going to leave," Kim said. "We had to get to the point of serving the force in a supporting role."

Kim made it a priority to capture and upload all of the medical advisory documents to one central database. But he did not have a way to translate this information to other languages at the time.

ARL computer translation experts hope to expand the military's ability to translate volumes of critical data, LaRocca said.

The Army Program Office associated with translation technology anticipates an Army need for three new languages a year and expanding domains to include legal, criminal justice, military training and medical, he said.

Handmade training aids in this medical training room in the Afghan Army clinic in Gardez, Paktia Province, Afghanistan, help U.S. mentors provide Afghan counterparts with knowledge of critical care techniques. (U.S. Army photos)

Civilian doctors in Afghanistan like this one in a clinic adjacent to Forward Operating Base Lightning and outside the city of Gardez in Paktia Province, received copies of the critical care manual translated during a partnership between doctors who were in the region and U.S. Army Research Laboratory researchers using computer translation technology.

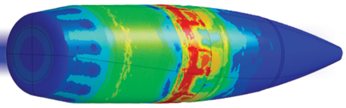
We have developed a way to curate data as fast as we translate it. We also have developed more than one way of capturing and reusing language data, he said.

"Although the manual may be worn in 10 years, the datasets captured from the translations will live on and be valuable for decades to come," LaRocca said.

When Kim was in Afghanistan, the physicians gave him a manual as an example of what they use for emergency war surgery that had been translated from Russian at least 40 years earlier.

"When U.S. forces are gone from the region, the U.S. documents will remain. As I see it, what ARL has done translates to tremendous training value to the physicians, as well as goodwill to the nation," he said. ■

COMPUTER SIMULATIONS



Improving lethality by using powerful computer models

BY ERIC KOWAL, PICATINNY ARSENAL PUBLIC AFFAIRS

With the steady increase in computing power, engineers are able to improve lethality with sophisticated computer models by eliminating unworkable designs.

Mechanical engineers can understand the effects different caliber ammunition will have on targets.

"We are able to get a more detailed small caliber lethality analysis with more advanced computer technology, by quantifying the numerous constituents of a ballistic event ending in the incapacitation of an individual," said Mark Minisi, technology team leader at the Small Caliber Munitions Division of the U.S. Army Armament Research, Development and Engineering Center at Picatinny Arsenal, New Jersey.

"It takes a significant complexity of computer power," Minisi said.

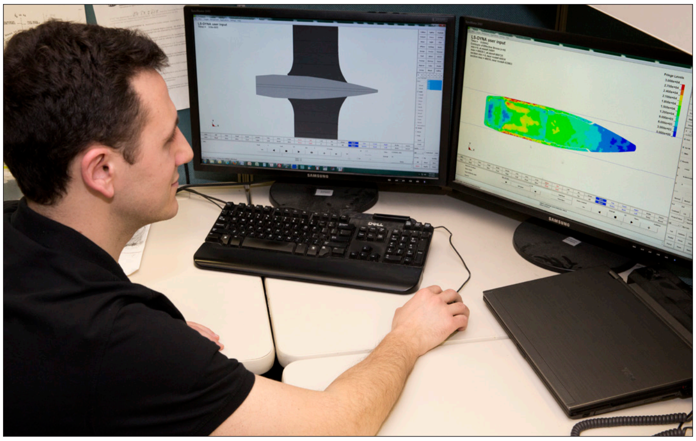
Powerful computers, Minisi noted, "help tackle larger problems and tackle more problems at once."

The research center's portfolio handles nearly 90 percent of the Army's lethality projects and all conventional ammunition for joint warfighters. One of the product groups include small-arms weapons systems with everything from 9 mm pistols to .50 caliber heavy machine guns.

With the release of the Army's newest 5.56 mm bullet, the M855A1 Enhanced Performance Round, researchers reached a milestone.

"Consistency and internal performance of EPR was accomplished through a combination of modeling, simulation and testing," Minisi said. "The use of newer, faster computers made critical portions of that effort possible. Some data was statistical, some physical and some probabilistic, but all done using physics-based models to simulate ballistics on soft targets."

ARDEC engineers partner with the other RDECOM organizations like the U.S. Army Research Laboratory Survivability/Lethality Analysis Directorate at Aberdeen Proving Ground, Maryland.



Michael Cataldi, a mechanical engineer and modeling and simulation analyst with the U.S. Army Armament Research, Development and Engineering Center uses Finite element modeling to evaluates structural integrating of small caliber munitions during launch. (U.S. Army photo by Todd Mozes)

"We frequently work with them on evaluation and development efforts," Minisi said.

ARL scientists conduct analytical investigations, modeling and simulations, and laboratory and field experiments to provide its analyses as well as technical advice and to be subject-matter experts on survivability and lethality matters to program executive officers and program managers, users, testers, the Army's independent evaluator and other customers.

Their products support milestone decisions concerning critical operational survivability and lethality issues for Army systems with critical survivability issues that could affect Soldiers' lives. In order to best serve the Army's analytical needs ARL leverages both research conducted across RDECOM, as well as other services.

Computer technology and software significantly minimize product development time by helping engineers to greatly reduce the number of prototypes, Minisi said.

Large caliber system analysis has taken advantage of computational simulation tools for years, while smaller caliber systems are starting to catch up, he said. The lag was a result of the cost differential in prototyping and testing between artillery and rifle munitions.

Prototypes can cost millions of dollars a piece. Modeling and simulation can save money by avoiding costly prototypes and testing.

"They can't just go make 20 and destroy them. They require a higher level of science," he said.

"In five years we might be down to three or even two prototypes," he said.

Engineers validate terminal performance models that cover a wide range of target variation through the use firing against a subset of targets and ensure the model is predictive.

A simulation that would have taken a team of engineers more than a week to prepare 10 years ago now takes 20 hours.

"I do not see an end to this continuous improvement," Minisi said. "We can make predictions with a high degree of confidence."

At one time, the computers the engineers first used were 32 processors and would average a cost of $500,000. Today the center has computers with more than 100 processors averaging about $100,000 per unit.

Minisi said ARDEC has been working with programs like Operational Requirement Based Casualty Assessment, known as ORCA. The program is the Army's premier tool, allowing assessments of Soldier performance following weapon-induced injury.

The ORCA modeling system incorporates previously developed as well as newly developed injury criteria models, algorithms and scoring systems to characterize human bio-response to trauma from various types of battlefield insults and derives estimates of Soldier performance degradation.

"They more we can do, the more we can realize all the things we can't do," Minisi said. "I can't model a whole human body ... but we are much closer than we were 10 years ago."

CYBER STRATEGY IN TACTICAL ENVIRONMENTS

Preparing to operate and fight in the cyber domain

BY KRISTEN KUSHIYAMA, CERDEC PUBLIC AFFAIRS

The U.S. Army is analyzing cyberspace requirements and outlining potential technical investments based on its Cyber Materiel Development Strategy released in February 2015.

Doctrinal, operational, acquisition and research and development communities for Army materiel development worked together for more than two years on the comprehensive strategy, which looks at where Army cyberspace capabilities currently are and what lies ahead.

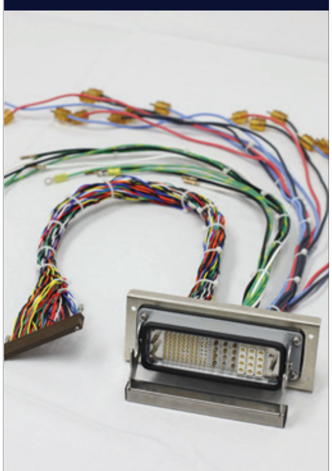
"The Army must be prepared to operate and fight within the Cyberspace Domain," said Assistant Secretary of the Army for Acquisition, Logistics and Technology Heidi Shyu. "It is essential ... that we use our limited acquisition and science and technology resources to identify and address critical Army specific problem sets and capability gaps. Where possible, we must leverage the best solutions and ideas available through our partnerships and collaboration within the Department of Defense, other government agencies, industry and academia."

Shyu appointed Henry Muller, director of the U.S. Army Communications-Electronics Research, Development and Engineering Center, or CERDEC, as the Army Cyber Task Force lead.

In less than two decades, cyberspace has radically transformed how the Army operates and wages war," Muller said. "Unlike the other physical domains, cyberspace will continue to grow and is projected to reach over 100 billion connected devices within just the next 10 years."

"These monetary and technological investments may determine how dominant the Army will remain in the future," Muller said.

The DOD has identified cyber as an operational domain much like air, land, maritime and space; however, no military service has been assigned the cyber domain. Additionally, the Army still operates in a fiscally constrained environment where spending and allocation of



resources cannot address all aspects of cyber, said Giorgio Bertoli, CERDEC Intelligence and Information Warfare Directorate, acting chief scientist and lead action officer for the strategy.

"Cyber is hard to predict," Bertoli said. "One of the challenges is the technology turnover rate is very high. Adoption for new technology is also increasing as the public becomes more and more comfortable embracing new technological advancements."

"You can predict that processing power is going to keep increasing; you can keep predicting bandwidth wired and wireless, is going to keep going up; you can predict new technologies like quantum computing will eventually come to pass," Bertoli said. "The hard part to predict is how are they going to be used? What are the new applications these technical advances are going to enable?"

CYBER FOR TACTICAL OPERATIONS

The Army identified that it needs to make advances in several Army-unique problem sets. One such area is the Army's tactical operations center where military specific operations occur. While its enterprise level network is similar to commercial businesses, the tactical network faces military-unique defensive and offensive challenges.

Tactical networks have limited bandwidth with high-bit error rates, high latency, intermittent connectivity, and roaming infrastructure and users.

"On top of that, you have other related data like mission command data that are passing over these very limited bandwidth channels to begin with. Any security you pass over these channels degrades what other traffic they can send," said Steven Lucas, chief engineer, CERDEC Space and Terrestrial Communications Directorate, Cyber Security and Information Assurance Division.

The Army is unique in that it operates for extended periods within adversarial environments.

"We're highly reliant on distributed communications systems, which are more prone to interception because you are in close proximity to the enemy within radio line of sight range," Bertoli said.

INTRUSION DETECTION AND NETWORK DEFENSE

One aspect of defending the tactical network includes intrusion detection.

"Intrusion detection allows a sensor to detect potentially malicious activity on a specific node, such as a handheld device or a laptop, and limit the user's capabilities," Lucas said.

"With respect to intrusion detection, you have sensors that are doing the detection of malicious activity, either on the network or at the host level, and whenever they detect something they feed it up to this higher authority," Lucas said. "Because of our environment, that connection between the authority and the actual detector may not always be there."

If the intrusion detection sensor spots potential malicious code on a handheld device, it might limit data transmission capabilities but still allow the Soldier to use the voice capabilities. The intrusion detection software would continue to monitor the device before determining if it needs to come off the network.

Another aspect of defending the network includes software assurance. Typically, one vendor does not develop code for single software application, but rather multiple vendors contribute to the code and then integrate it into one package.

CERDEC and the U.S. Army Research Laboratory have developed various techniques, such as fuzzing, to analyze binary code to identify potential holes in the software.

"Fuzzing is where you throw garbage at the executable code and try to get the software to do something that it wasn't designed to do," Lucas said. "Then through analysis, you can see if there was a buffer overflow or a memory leak where now it opens a potentially exploitable window into that software."

From the research and development side, CERDEC wants to perform the majority of software analysis upfront before the system is fielded. Not only will it protect Soldiers from using vulnerable software, but it will also save the Army time and money in development and sustainment.

"Software analysis is a continuous process you need to do, and then we also have developed capabilities to where ultimately we don't want to wait to the very end just before the application goes out to the field," Lucas said. "Do it up front, do it during the actual coded development and writing, where you can ultimately save."

Based on a calculation done on a mission command application, if a vulnerability in a system was found during the development cycle instead of the pre-deployment phase, the government could save roughly $30 million over the entire program lifecycle, he said.

Access Control and Identity Management

An additional tactical concern is access control and identity management at all levels across the network, as there may be a mixture of cleared and uncleared users.

Most employees associated with the government are familiar with the Common Access Card, or CAC, which allows two-factor identification to gain access to government issued computers.

This form of two-factor identification works adequately for stationary systems in an enterprise and non-dynamic environment, such as an office cubicle; however, a CAC is not the most practical access control and identity management tool for many environments, Lucas said.

"Ultimately how you come up with or maintain that trust consistently across the network is very hard to do," Lucas said. "From a device perspective, the user needs to have trust in the device, which provides the information to them to make decisions. You want to ensure that nobody can just add a device of their own, like an enemy laptop, to the network. You want the devices themselves to be trusted."

CERDEC is working with project managers and the Chief Information Officer/G6 to research, design, develop, and test state-of-the-art identity management systems that will work in the unique tactical environment.

OFFENSIVE CYBER OPERATIONS

The Army Cyber Strategy calls for the continued effort to further protect its tactical networks, but it also calls for research and development on how the Army can leverage its own sensors and exploit enemy capabilities.

"Offensive Cyberspace Operations provide a military commander a non-kinetic capability option that eliminates or minimizes the physical damage caused by other traditional forms of military engagement," Bertoli said.

"One of the key things we've been pushing for a while now is that we need to do a better job of leveraging our tactical assets to improve CEMA [cyber electromagnetic activities] situational awareness," Bertoli said.

As part of the strategy, the Army will continue to determine how it can best leverage sensors that are already in the field to enable such cyber capabilities.

Research Infrastructure

In order to make these offensive and defensive advances, the Army needs to base its development on a modular and flexible architecture to ensure it can keep with the continually increasing advancements in cyberspace.

It is impractical for the Army to chase after every new technology to defeat it; however, it is possible and fundamentally important to further develop architecture frameworks that will minimize the amount of new code needed to deal with new technologies, Bertoli said.

"In order to achieve this, you need to have some pretty extensive laboratory infrastructure like we have here at APG, and those labs have to be constantly updated to keep up with the churn of technology," Bertoli said.

"Though a great first step, the Army is still working at defining its role and doctrine as related to cyberspace operations. This, coupled with the rapid pace of technical innovation within the domain will require the S&T, operational, doctrinal and acquisition communities to maintain close working relationship and to ensure this strategy remains current," Bertoli said. ■

COMMANDER'S Virtual Staff

Army applies computer automation to operational decision making

BY CERDEC PUBLIC AFFAIRS

Apple's Siri. IBM's Watson. Google Now. These well-known systems attempt to interact with humans in natural ways, solve complex problems, try to evolve, and continually better understand their environments and the humans with whom they interact.

Sound familiar? In many ways, each of these technologies are acting much like a staff for their human counterparts. The U.S. Army Communications-Electronics Research, Development and Engineering Center is seeking to apply cognitive computing, artificial intelligence and computer automation to support tactical decision making for Army commanders and staff.

CERDEC will launch a new science and technology project next year called the Commander's Virtual Staff, or CVS, which seeks to fundamentally transform how automation is delivered to commanders.

"We have made real progress in getting decision makers data, whether they need it or not; now we need to give them not just data, but information and knowledge as well as decision-aiding tools," said John Willison, CERDEC Command, Power and Integration director.

Studies show that battalion commanders are unhappy with the number of systems that must be consulted and the volumes of data that must be mentally processed to make decisions, according to the Mission Command Center of Excellence at Fort Leavenworth, Kansas.

To achieve situational understanding, commanders must interact with a large number of support staff and examine different computer systems, all while mentally fusing large data sets to perform informed decision making.

The CVS project will provide computer automation specifically targeted to commanders and their close staff by exploring today's commercial technologies and advances in artificial intelligence that provide users with proactive suggestions, advanced analytics and natural interaction tailored to the user's unique needs and preferences.

"There's been limited machine support designed to integrate across warfighting functions and facilitate mission command tasks," said Lt. Col. Michael A. Baker, Command, Power and Integration military deputy. "CVS will leverage automation and cognitive computing

Commander's Virtual Staff will explore commercial technologies and advances in artificial intelligence as part of its efforts to support tactical decision making for Army commanders and their staff. (U.S. Army photo) technologies to grapple with countless data sources and intense situational complexity on the battlefield, not to make decisions, but to help commanders make better more informed decisions."

Army researchers hope to provide a suite of tools to enhance the commander's ability to understand, visualize, describe and direct. In addition to automated support for executing operations processes, the project will offer decision support software for all phases of the operations process from planning, preparation, execution and after action reviews.

Some of the major capabilities will include data aggregation, integrated agile planning, computer-assisted running estimates, continuous predictions of events based current mission and situational awareness data, recommendations and options.

The program will provide data aggregation by interfacing into existing command post systems to consolidate and mediate information as needed—whether that be from staff computer systems, sensors or Soldiers—and provide the commander with an aggregated data collection.

The integrated agile planning capability will be able to produce an electronic representation of the mission that can be used to facilitate war gaming, preparation, rehearsal and provide coordination during mission execution for both human and autonomous systems.

"With CVS, we're after a less familiar sort of autonomy found inside command and staff support systems and servers as opposed to better known examples such as route planning for UAVs and ground robots," Baker said. "CVS will support goal-directed systems by better capturing and interpreting user intent to focus situational assessments, develop and analyze potential courses of action and identify unanticipated risks and threats."

The assessment capability will continually compare the current situation against the intent of the commander's plan to assess whether or not decisions need to be made and to advise when situations may require attention. These computer-assisted running estimates will provide the commander and staff a continual flow of recognized risks and opportunities based on how well the state of the real world tracks the world envisioned in the commander's intent.

While the prediction capability can be used to generate alerts and provide a future operating picture with associated confidence levels, operations and recommendations will be continuously generated based on mission goals, local knowledge, predictions and the current situation. It will provide the commander with a range of options for consideration in any given situation and provide an analysis of the relative merits of each. The intent is for humans to be aware of choices and their associated cost/benefit analysis, but not to have CVS make the decision.

"Machine learning as well as user configuration will improve the system over time to better support specific individual and organizational processes and preferences. Behaviors may be tuned by users during training or following real-world engagements so that the system grows with the commander and staff," Baker said. "CVS objectives include learning and recognizing user patterns, testing and updating models of enemy tactics as well as local environments to continually improve assessments. Configurations used by successful commanders may ultimately provide a priceless digital record of knowledge, processes and experiences useful for training new commanders."

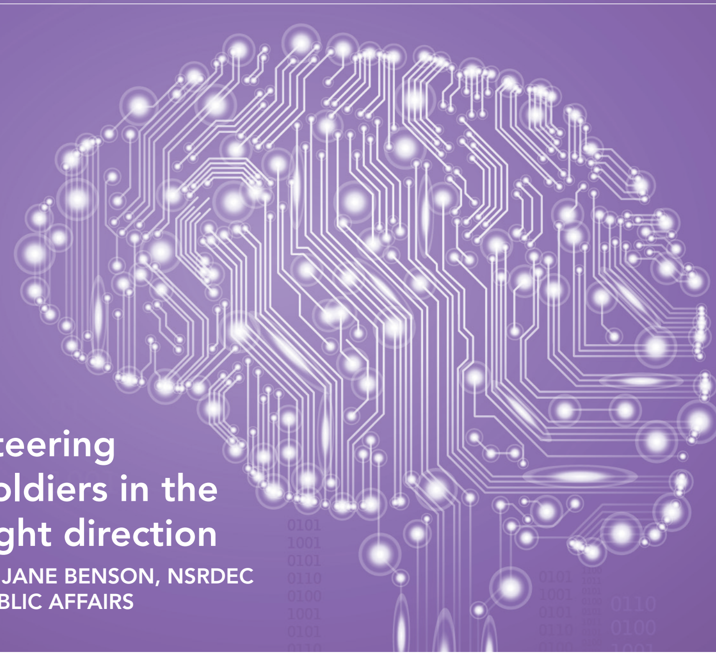
The project is part of Army researcher's long-term vision for supplying mission command, directly supporting the Army's Operating Concept 2020-2040 and the Army's key technology imperatives to execute mission command, enhance situational understanding, optimize human performance and help develop key leaders.

CERDEC is extending previous work and lessons learned from programs such as its Mission Command and Actionable Intelligence Technology Capability Demonstration and Commander's Toolkit, which provide tools to push proactive information to small unit leaders before they need to ask for it.

The design team will use an open framework to invite contribution and extension from experts in multiple fields. The open software platform will be designed to be an integration point for technologies developed by CERDEC directorates, as well as contributions from other DoD S&T organizations. The project will act as the incubator for developing a series of useful digital decision support capabilities to be transitioned to programs of record.

"We will look to leverage industry, academia, and the Research Labs to define and develop a program that reduces the commander's cognitive burden. CVS will provide future forces with the decisive agility necessary to be able to see, understand, decide and act more quickly than their opponents," said Lisa Heidelberg, chief for CP&I Mission Command Capabilities Division.

COGNITIVE SCIENCE RESEARCH



Steering Soldiers in the right direction

BY JANE BENSON, NSRDEC PUBLIC AFFAIRS

Soldiers face special challenges during navigation. Their jobs are physically demanding. They are often under extreme stress, and they often need to make quick decisions in an ever-changing and sometimes dangerous environment. They may be cold, hot, hungry or tired. All of these factors can affect the ability to make wise navigation decisions.

Army researchers use virtual reality to test to test Soldiers and discover influences on choices people make when choosing a route.

Dr. Tad Brunyé, a member of the Cognitive Science Team at the Natick Soldier Research, Development and Engineering Center, investigates spatial and non-spatial influences on Soldier navigation choices.

"This type of knowledge will help optimize Soldier performance," Brunyé said. "Soldiers also show reliable biases in memory for landmark locations due to the emotional nature of events that transpired at that location."

Spatial influences pertain to things in an actual space, such as topography, local and distant landmarks, or the position of the sun.

Dr. Tad Brunyé (right) and Breanne Hawes, U.S. Army Natick Soldier Research, Development and Engineering Center Cognitive Science Team, examine brain hemodynamic and electroencephalography results for a study examining the brain signatures of mental workload during virtual navigation research. (U.S. Army photo by David Kamm)

Non-spatial influences are a little harder to define and can include a Soldier's emotional state, level of stress, mission and task demands, skills, abilities, traits, and his or her past experience in a geographical area, all of which can affect navigational choices.

We are still trying to identify and characterize the full range of spatial and non-spatial influences and how they interact with emerging representations of experienced environments," Brunyé said. "We all have our current mental states. So, you may see the same landmarks as I do, you may see the same topography that I do, but I might be in a very different state that leads me to interpret and use that same information in very different ways.

Virtual reality capabilities, including head-mounted display systems, have revolutionized cognitive science research by allowing Soldiers to get engaged in visual worlds, scenarios and tasks that accurately emulate aspects of operational experience while maintaining important experimental controls.

"As part of our goal to understand, predict, and optimize navigation behavior, we have leveraged virtual reality research and technologies to advance the state of the art in spatial cognition research and gain new insights into the brain mechanisms, strategies, and biases that Soldiers use when selecting routes, learning new environments, and solving complex problems," he said. "By better understanding and predicting Soldier spatial behavior we can identify, prioritize, and optimize technological capabilities to fill gaps in Soldier knowledge to support flexible spatial behavior without overburdening perceptual, attentive, or cognitive resources."

Individual cognitive abilities and individual personalities can also affect navigation choices. Brunyé has found that good navigators tend to be more open to new experiences and are less anxious than poor navigators.

"How confident do I feel in my environment? Is there a history of enemy activity? Are there certain areas I want to avoid? Are there certain safe spots that I want to keep in mind? There is always interplay between what you sense in the environment, what you perceive, what you know, what you predict will occur, and ultimately how you act."

There are also misperceptions that influence navigation choices. One of the key discoveries made by NSRDEC researchers is that many people will choose a route that goes south because they equate going south with going downhill. They perceive a southern route as easier than a northern route, which they equate with going uphill. This incorrect assumption can lead to less than optimal navigation choices.

"This finding has been coined the 'north-is-up' heuristic, and has been replicated in not only the USA, but also in Bulgaria, Italy, and the Netherlands," Brunyé said.

Moreover, Brunyé said that right-handed people tend to prefer making right turns. Left-handed people prefer going left, and most people will chose a route that is straight initially, even if it curves and becomes suboptimal later in the journey.

"At this stage of our research we are tasked with understanding and quantifying the conditions under which various heuristics and behaviors emerge, and how they might interact with one another to guide navigation behavior," Brunyé said.

By studying and monitoring people's choices in navigation (through non-intrusive devices and methods) and by observing patterns of physiology and neurophysiology, Brunyé is developing ways to predict behavior and optimize navigation performance. The goal is to incorporate his observations into Soldier training, providing Soldiers with concrete tips for becoming better navigators in a variety of situations. In addition to training, Brunyé is exploring redesigning tasks and support technologies to better match individual and contextually guided Soldier capabilities and limitations.

The team is also investigating stimulating areas of the brain with low-current, electrical charges. Brunyé said that the low-current charges have been shown to help some poor navigators become better navigators, but the charges do little to help those who are already competent navigators. Brunyé pointed out that brain stimulation could also ultimately be used to accelerate learning or help Soldiers overcome barriers to flexible performance, such as fear, anxiety or lack of confidence.

"Being a scientist at NSRDEC affords working on a wide range of impactful research programs that result in innovative technological solutions for optimizing Soldier cognition and action," Brunyé said. "This project has been particularly rewarding given its direct fit with my training and expertise, and its direct relevance to a real-world problem space."

The research is expected to have a major impact in the future.

"The knowledge garnered from this research could ultimately affect military strategy, including predicting which way an enemy will go," Brunyé said. "The research also could help predict the movement of friendly personnel who are disoriented or lost. By understanding the way the mind works, we can make some predictions about what people are going to do when they are lost or isolated. This knowledge will help improve survivability and mission effectiveness."

VIRTUAL IS REALITY

Natick aims to help subject matter experts see big picture

BY JANE BENSON, NSRDEC PUBLIC AFFAIRS

Natick researchers are creating a virtual world to provide an accurate, instant and interactive snapshot of the Soldier and his or her equipment.

With optimal performance in mind, Rick Haddad and the Soldier Capabilities Integration Team from the U.S. Army Natick Soldier Research, Development and Engineering Center are working to ensure the Soldier and equipment work together in concert.

"We developed a likely task scenario environment that a Soldier or squad would be operating in and took every protection project and found where it most likely would have value to the warfighter within the scenario," Haddad said. "We created a visual where people could see how their project fits in the operational environment and how it works with other products."

The team created a virtual demonstration of 77 projects. In the long-term, Haddad said he hopes the virtual demonstration will spark the development of a web-based interactive tool that will extend across Army Science and Technology to make products for the Soldier more compatible and enhance Soldier performance.

By making subject matter experts aware of this novel demonstration methodology, researchers hope others within the Army S&T community will get involved and provide information about their own projects.

The virtual demonstrator increases SME awareness of where Soldier products fall in the big scheme of things, where a product lies in the execution of a Soldier's mission, and how different components need to work together.

Scientists, engineers and other subject matter experts will ultimately be the users who will interface with a data architectural environment, so getting their input now is crucial. The virtual demonstrator is part of a much larger, Army-wide, Soldier System Engineering Architecture effort.

Natick's focus areas include the Combat Feeding Directorate, Warfighter Directorate, Aerial Delivery Directorate and the Expeditionary Basing and Collective Protection Directorate, which Haddad said makes NSRDEC a good starting point for the virtual demonstration. Each area has a role spanning across warfighter missions, from the base camp to the complex area of operation.

"We are the Soldier domain," said Mary Giacalone, an NSRDEC program analyst who is working with Haddad on early deliverables. "We're here to support the needs and requirements of the Soldier."

When looking at the Soldier as a system, experts at NSRDEC recognize that not only is the sum greater than all the parts, the parts need to work together seamlessly in order for the nation's warfighters to be at their very best.

Currently, Army scientists and engineers develop Soldier equipment to enable Soldiers to reach optimal performance. Sometimes, it is hard to know what researchers in other areas have developed, and this can lead to unforeseen compatibility problems or to the Soldier's load becoming too heavy, Haddad said.

Mary Giacalone, an NSRDEC program analyst (left) and Rick Haddad, co-lead for the Force Protection, Soldier and Small Unit, Science and Technology Objective Demonstration, work on early deliverables on a virtual demonstrator, which is part of a much larger, Army-wide, Soldier System Engineering Architecture effort. (U.S. Army photo by David Kamm)

"Even a pound, when multiplied over the course of a mission, can have a tremendous impact on Soldier performance, depending on the task he or she is asked to execute," he said.

The team is working to make information accessible, sortable and leverageable. The demonstrator features clickable panels to navigate a mission and the necessary technologies to support that portion of the mission. Down the road, this information will be available via website.

"It's an integrated approach," Haddad said. "We need to develop tools that enable consideration of the Soldier, the equipment and the task."

The goal is to see projects laid out from the base-camp-planning phase to the mission-execution phase and every step in between.

"Operational context is important," he said. "Good science doesn't always equal good outcome. This project will help our scientists, engineers and user community partners become more aware of the operational impact of our proposed capabilities that we want to deliver to the warfighter. We want to get people onboard with shaping their future computing environment, their future database experience.

"If we have their input, we will have a better user interface. We want it to get to the point where someone can type in, for example, 'protection for the torso,' and several material and nonmaterial solutions that need to be taken into consideration will pop up," he said. "That's where we hope to get to."

Haddad and Jaclyn Fontecchio are co-leads for the Force Protection, Soldier and Small Unit, Science and Technology Objective Demonstration.

VIRTUALLY HUMAN

Researchers explore powerful medium for experiential learning

BY ORLI BELMAN, USC INSTITUTE FOR CREATIVE TECHNOLOGIES

New research aims to get robots and humans to speak the same language to improve communication in fast-moving and unpredictable situations.

Scientists from the U.S. Army Research Laboratory and the University of Southern California Institute for Creative Technologies are exploring the potential of developing a flexible multi-modal human-robot dialogue that includes natural language, along with text, images and video processing.

"Research and technology are essential for providing the best capabilities to our warfighters," said Dr. Laurel Allender, director of the ARL Human Research and Engineering Directorate. "This is especially so for the immersive and live-training environments we are developing to achieve squad overmatch and to optimize Soldier performance, both mentally and physically."

The collaboration between the Army and ICT addresses the needs of current and future Soldiers by enhancing the effectiveness of the immersive training environment through the use of realistic avatars, virtual humans and intelligent agent technologies, she said.

For ICT, an Army-sponsored university affiliated research center, the study builds on a body of research in creating virtual humans and related technologies that are focused on expanding the ways Soldiers can interact with computers, optimizing performance in the human dimension, and providing low-overhead, easily accessible and higher-fidelity training.

The mission of the Los Angeles-based institute is to conduct basic and applied research and create advanced immersive experiences that leverage research technologies and the art of entertainment and storytelling to simulate the human experience to benefit learning, education, health, human performance and knowledge.

Toward that goal, much effort focuses on how to build computers—virtual humans and also robots—that can interact with people in meaningful ways.

"Our scientists are leaders in the fields of artificial intelligence, graphics, virtual reality and computer and story-based learning and what is unique about our institute is that they bring their disparate expertise together to find new ways to solve problems," said Randall W. Hill Jr., ICT executive director. "Being managed by ARL also provides great opportunities for collaboration and for aligning our research priorities with Army needs."

ICT's interactive virtual humans serve as mentors, role players, screeners and more. Some of these autonomous intelligent agents are designed to help develop leadership skills or to help prevent suicide, sexual assault and harassment.

Researchers are advancing techniques and technologies for allowing them to speak, understand, move, appear and act in ever more believable ways. Their work in these areas has led to virtual human research efforts that inform fields beyond virtual humans, including robotics.

Studies of emotion and rapport are leading to computational systems that communicate more effectively. Ellie, one of ICT's most advanced virtual humans,

As part of ICT's SimSensei project, Ellie can read and react to human emotion by sensing smiles, frowns, gaze shifts and other non-verbal behaviors, as well as analyzing the content of the speech. She can engage in dialogue, deciding when to prompt for more information, or give empathic feedback to a user response. (Graphics courtesy ICT) can read and react to human emotion by sensing smiles, frowns, gaze shifts and other non-verbal behaviors, as well as analyzing the content of the speech. She can engage in dialogue, deciding when to prompt for more information, or give empathic feedback to a user response. Ellie has interviewed more than 600 people as part of ICT's SimSensei project, a DARPA-funded effort to help identify people with depression and PTSD.

It turns out Ellie is good at her job. A recent study suggests people who spoke to Ellie were willing to reveal more to her than to a real person.

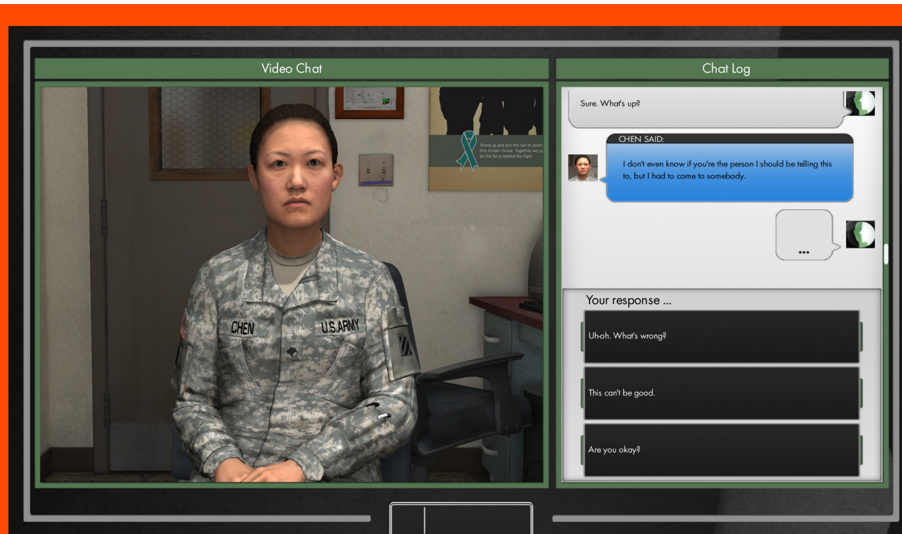
"Our group has been working since 2000 on studying human dialogue, developing computational models of dialogue, building dialogue systems to interact with people and building dialogue components of integrated virtual humans," said David Traum, director of the ICT Natural Language and Dialogue Group. "Our goal is to create computational models of purposeful communication between individuals, and it is gratifying that our basic research has led to a variety of Army applications."

ICT virtual characters and supporting architecture contributed to the Army's Intelligence and Electronic Warfare Tactical Proficiency Trainer. Within the Program Executive Office Simulation, Training, and Instrumentation, known as PEO STRI, a Project Manager Constructive Simulation value engineering proposal estimated that the project saved the Army close to $35 million by incorporating ICT-based natural language capabilities.

Other applications include the virtual Sgt. Star, who answers questions about Army careers for the Army Accessions Command and Radiobots, dialogue systems that could function as radio operators for constructive simulations. This frees up operators from routine communications and data entry.

Current applied projects using ICT natural language research include the Virtual Standard Patient, or VSP, and Emergent Leader Immersive Training Environment. VSP allows educators to create virtual role players for medical students to engage to practice interview and diagnostic skills.

Natural language understanding, or NLU, and dialogue management technology developed at ICT allows the virtual role players to respond appropriately to student queries. An NLU component also enables



Top: *In the Army's Emergent Leader Immersive Training Environment, or ELITE, Soldiers hone their basic counseling skills through practice with virtual humans like virtual Staff Sergeant Jessica Chen.*

Above: *Javier leverages ICT's natural language understanding and dialogue management technology so future clinicians to practice their interview and diagnostic skills online.*

Soldiers Army-wide to practice interpersonal communication skills with the virtual staff sergeants in ELITE. The trainer can be downloaded from the Mil.Gaming portal and is in use at the U.S. Military Academy, ROTC, the Basic Officers' Leader Course and the Warrior Leader Course.

In their collaboration looking into developing a possible a human-robot dialogue, ICT researchers, along with their ARL collaborators, are exploring more than whether they can enable robots to function better in uncertain conditions, they are expanding the ways Soldiers will interact with robotic team members, autonomous vehicles, training and simulations.

"By developing tools and technologies for man and machine to converse with and understand one another, ICT researchers, in collaboration with the Army Research Lab and many groups throughout the Army and DOD, are providing ways to better communicate, be it personal information that can lead to mental health support, or planning information for better situational awareness," said John Hart, ICT program manager at ARL-HRED's Simulation and Training Technology Center. "Their work in human-computer interaction is also paving the way for what will be possible in the future."

Now that is something to talk about. ■

MINIATURIZATION

Where good ideas and technology meet BY AMRDEC PUBLIC AFFAIRS

Miniaturization and advances in computing have had an enormous impact on all aspects of life—especially in the realm of digital image and signal processing.

Only a decade or two ago, appreciable computing power required to perform military-grade image and signal processing tasks necessitated large, clunky computers or racks of dedicated processors.

Now, powerful processing speeds and computational capability are common in tablet computers and even smart phones.

The U.S. Army Aviation and Missile Research, Development and Engineering Center now has advanced computational power capabilities in a package small enough to bring complex image and signal processing technology to small battlefield weapons.

"We are leveraging advances in computer technology to push the Army's state-of-the-art in a diverse range of military applications," said Steven Vanstone, AMRDEC Image and Signal Processing Function acting chief.

Advances in computer technology are perhaps most evident in developments targeted for battlefield applications, Vanstone said.

"Image processing applications such as automatic target acquisition and tracking, have been developed in an ad hoc fashion, where an algorithm du jour is forced into a system with no effort given to understanding," said Don Waagen, an AMRDEC electronics engineer. "Is this the right algorithm for this problem?"

Waagen and his team are working to shift the mindset applied to Army imaging sensor processing by understanding the nature of the measurements and by understanding the algorithms available to work on those measurements. Once the core features available in a given sensor space are understood, the team intelligently chooses and modifies available algorithms that best operate on the given measurement space, Waagen said.

One area where Army engineers applied this approach is in the development of precision target acquisition. This brings video game-style warfare to the battlefield by allowing Soldiers to select a target of interest from a reconnaissance image and send targeting information to a missile for true lock-on-after-launch engagement.

When the missile system is onboard a unmanned aerial system, it ensures the safety of the Soldier by providing excellent standoff engagement, while at the same time providing surgical precision engagement.

For this operational concept, Army researchers first had to extensively understand the feature space to overcome the enormous challenge of operating across different wavebands used by the unmanned aircraft systems and missile sensors, Vanstone said.

The team is developing this capability with the AMRDEC-developed Modular Missile Technologies 2.75-inch diameter variant of open-architecture missiles. The collaboration provides a totally government-owned seeker package, allowing precise target engagement.

"Trying to fit this kind of computation into a 2.75-inch missile constraint was unheard of until very recently," said Shane Thompson, electronics engineer with AMRDEC Image and Signal Processing Function and the Precision Target Acquisition technical lead.

Fifteen years ago, the Army demonstrated the basic concept with a missile flight test under the Future Missile Technology Integration program. The onboard processor performed only the autotracker algorithm and missile guidance. The target acquisition processing had to be performed at the ground station and required a large computer with specialized processor boards to enable real-time running. Imagery from the missile seeker traveled to the ground station via a high-speed data link. After target acquisition processing, the target location traveled back up the datalink to close the guidance loop with the autotracker.

"Now, because of the advances in computing in small packages, we are able to perform both target acquisition and tracking on a processor board slightly larger than a credit card, which will fit within the 2.75-inch missile size constraint," Thompson said.

AMRDEC engineers and scientists are also pursuing a number of good ideas through a diverse portfolio of science and technology projects that continually seeks increasing technological advances to enhance battlefield performance, Vanstone said.

"Sometimes, good ideas have to wait for technology to catch up," he said. ■

Shane Thompson, an electronics engineer with the U.S. Army Aviation and Missile Research, Development and Engineering Center at Redstone Arsenal, Alabama, displays a compact processor board, developed by AMRDEC's Image and Signal Processing Function, which performs both target acquisition and tracking. (U.S. Army photo by Nikki Montgomery)

Unleash the Power

DOD Supercomputing Resource Center achieves four petaflops

BY JOYCE P. BRAYBOY, ARL PUBLIC AFFAIRS

When Lila Todd Butler graduated from Temple University in 1941 as the only female mathematician in a class of 1,600, she had no idea she would be one of the computer programmers of ENIAC, the first general-purpose electronic digital computer.

Butler retired from the Ballistics Research Laboratory in 1979 after having written the book of routines that ran the ENIAC and having dedicated her life to developing scientific computer languages.

When she and five other women who had worked at the U.S. Army Research Laboratory's predecessor laboratory, BRL, returned nearly 20 years later for the ribbon-cutting ceremony for what we know today as the U.S. Army Research Laboratory Defense Supercomputing Resource Center in 1996, it marked a new era of high-performance computing at Aberdeen Proving Ground, Maryland.

In 1996, they were asking questions like, Who controls the Internet?

"The most powerful computer when I came to ARL, had four central processing units, the newest Cray XC-40 has more than 100,000 CPUs. The machines are getting more powerful and larger physically," said Lee Ann Brainard, deputy director at the ARL DSRC.

The DSRC Cray XC-40, was listed as number 19 on the world's top 500 list of most powerful supercomputers last year. "The Cray gives five times more computing power and 10 times more memory than we had just two years earlier," she said.

The supercomputer consists of 101,312 computer cores, 32 general-purpose computing on graphics processing units, or GPGPUs, and 411 terabytes of memory, and provides 3.77 petaflops of peak computing capability, she said.

"We empower researchers to solve the most difficult military operational challenges through advanced computing," said Dr. Raju Namburu, ARL DSRC director. "DoD scientists and engineers use the different aspects of high performance computing to design and develop better Army materiel systems at a faster pace to increase the nation's security.

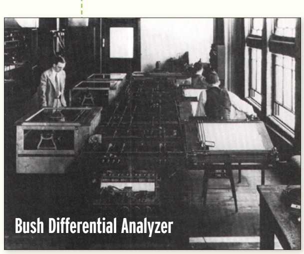
LABORATORY COMPUTING

The Early Years (1935 – 1976)

The Ballistic Research Laboratory played a significant role in the evolution of scientific computing architectures and technologies. The automatic computing and data processing industry is a direct outgrowth of research, sponsored by the U.S. Army Ordnance Corps, which produced the ENIAC, the world's first electronic digital computer in 1946.

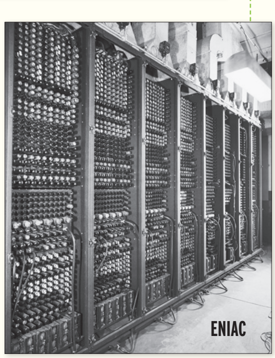
In their day, these scientific computing systems were among the most powerful and technologically advanced computers in the world.

1935



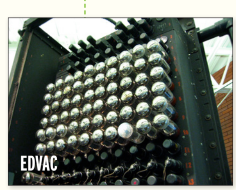
Bush Differential Analyzer

1946



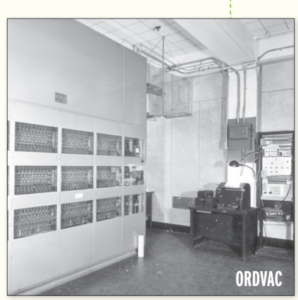
ENIAC

1949



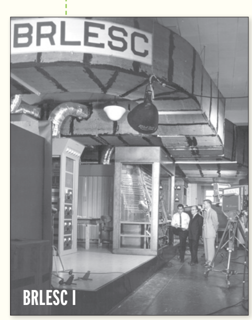
EDVAC

1952



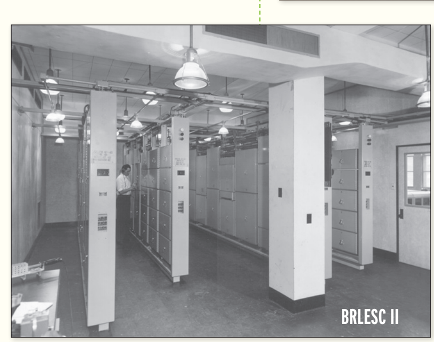
ORDVAC

1961



BRLESC I

1966



BRLESC II

1976

CDC Cyber 7600

"High performance computing based predictive simulations offer virtual testing of complex experiments. At the ARL DSRC Army vehicle animations could be rotated, taken back and forward in time, manipulated and improved with a fraction of the time it takes to conduct a series of experiments," he said. "You also are left with more interesting data to work with in determining what just happened, why, and how to improve."

At a place like ARL, where the nature of the work is exploring technology for Soldiers 10 or 20 years from now, quantum, bio- and neuron-based computing, are on the horizon for the deep future, Kendall said.

ARL is always looking to emerging computing architectures that could help not only to keep up with growth of the technology, but also to deploy power-aware multi-petaflop computing capability on the battlefield," Namburu said.

Brainard expects the next upgrade for the ARL DSRC to start in 2016. The DOD High-Performance Computing Modernization Program typically invests in supercomputing capabilities at the facility every two years.

As Brainard stood in a large empty room, she said it will be the home of the system to come, which is prepared over a year before the system is expected.

Each biennial upgrade comes with a set of challenges. In 2012, it was puzzling to figure out how the ARL DSRC was going to be able to maintain its daily operations while moving to a new building. They had to forecast the expansion needs for that upgrade for years to come. In 2014, the logistics of a partnership with the Installation Management Command was the hurdle. ARL partnered with IMCOM to add a 2,000-ton water plant to keep the systems watercooled in a way that uses less energy than using both air- and water-cooling together, Kendall said.

CrayXC40 – The newest ARL system, DSRC Cray XC-40, was listed as number 19 on the world's top 500 list of most powerful supercomputers Nov. 17, 2014. (Image courtesy Cray)

"Forty-two hundred gallons of fluid run through the pump every minute to maintain the temperature for the machinery," he said.

When you look at the massive machines and the three-or-four car garage equivalent space that holds the machine's cooling system, it is hard to imagine getting this capability closer to operational theater, but over the next 20 year it is the laboratory's goal to provide 100 petaflop computing power in the battlespace.

"A [petaflop-capable] machine is not something we could transport on a High Mobility Multipurpose Wheeled Vehicle, or HMMWV, into theater soon," Brainard said. "But in time."

The power of high-performance computing brings ideas that were unheard 20 years ago into the realm of possibility for scientists and engineers, including HPC simulation-based design of novel materials from molecular scale to continuum scale, she said.

EARLY COMMERCIAL SCIENTIFIC COMPUTING SYSTEMS

The Army Supercomputing Program

By the mid 1970s, the commercial high-performance computing industry had matured to the point that the laboratory could more effectively exploit commercial scientific computing technologies without the time and cost to build in-house systems. The laboratory continued to play a key role in the design and development of these commercial systems by driving the technical requirements for technologies like large memory, use of the UNIX operating system, innovative graphical Interfaces and tools.

The Army established its supercomputing program to enable the availability of high-performance computer systems, which had become essential to the Army research community. The Ballistics Research Laboratory again provided top-level leadership, guidance and funding strategies for the Army and DOD to establish, mature and sustain a viable and successful program.

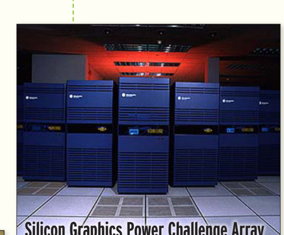
1983

1986

1987

1993

1995



A molecular dynamics program from Sandia National Laboratories called Large-scale Atomic/Molecular Massively Parallel Simulator, or LAMMPS, is an example of advanced software that takes advantage of the ARL DSRC petaflop computational power. Macromolecular scientists use the program to look closely at dynamic properties of materials, such as polymers that affect Soldier protection, said Tanya Chantawansri, ARL materials scientist.

ARL's supercomputing reached its first petaflop in 2012, and today the HPCMP's aggregate supercomputing capability across the DOD is more than 26 petaflops. A petaflop is the ability of a computer to do one quadrillion floating point operations per second, or FLOPs.

According to the HPCM website, they more than doubled the aggregate DOD supercomputing capability during the 2014 round of upgrades.

"The large leaps are harder to sustain without emerging processing trends," Kendall said. "The machine's performance is also harder to access as we grow."

For a long time ARL had a unique computing ability. "We were one of the first 50 websites in existence, while there are billions of websites today. But as technology proliferates, everyone around the world has greater access. It makes having a lead advantage become more critical, and harder," Kendall said.

The toughest challenges are yet to come. "To deploy and leverage multi-petaflop computing power on the battlefield will be the ultimate challenge," Kendall said. ■

The U.S. Army Research Laboratory, Department of Defense Supercomputing Resource Center is a computational science facility that supports Department of Defense research, development, test and evaluation for the user communities with high-performance computing resources and technology.

THE MODERN ERA OF SUPERCOMPUTING

In 1996, the Army Research Laboratory became one of four large-scale Defense supercomputing centers within the DOD High Performance Computing Modernization Program. The ARL Defense Supercomputing Resource Centerv carries forward the laboratory's tradition of exploiting the power, capability, performance and utility of today's scientific computing systems.

The center has evolved tremendously since 1996 and the following timeline provides a brief overview of the rapid evolution of DSRC computing systems.

1996


Origin 2000


Cray J932


Cray T90

1998

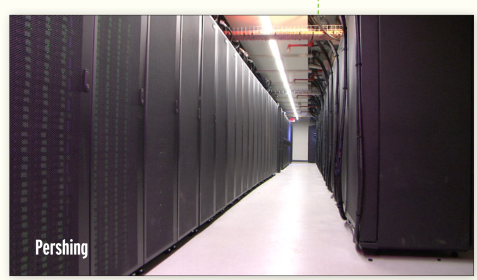

Sun Enterprise 10000

2000


Cray SV-1


SGI Origin 3800

2012


Pershing

2013


IBM Heterogeneous Cluster

RDECOM welcomes new command sergeant major

By Dan Lafontaine, RDECOM Public Affairs

The U.S. Army Research, Development and Engineering Command welcomed a new senior noncommissioned officer March 12.

Command Sgt. Maj. James P. Snyder assumed duties as the RDECOM principal adviser to the commanding general for enlisted matters during a change of responsibility ceremony at Myer Auditorium. More than 250 Soldiers and Army civilian employees welcomed Snyder and his family to RDECOM and APG.

Command Sgt. Maj. James P. Snyder assumed responsibility as the U.S. Army Research, Development and Engineering Command senior enlisted advisor March 12, 2015. (U.S. Army photo)

Snyder takes over for Command Sgt. Maj. Lebert O. Beharie, who has served as the command's senior enlisted adviser since March 16, 2012. Beharie retires after 30 years of service.

"What a great opportunity to be a part of a unique and diverse organization that is focused on the future success of our warfighters," Snyder said. "From the little I have already seen, it will be a very rewarding assignment.

"I am humbled to be able to serve this command."

Maj. Gen. John F. Wharton, RDECOM commanding general, thanked Beharie for his dedication to RDECOM, the Army and nation.

"Command Sergeant Major Beharie has been the link between the warfighter and all the technology that we do," Wharton said. "He has a vast history of operational experience and a total of six combat deployments. That's the kind of leader who can tell you what it's like in the field and what technologies we need.

"He is a consummate professional, a mentor and someone who exemplifies the Army's values. He simply represents the Army's best. He served as an ambassador, not only for RDECOM, but for AMC and the Army."

RDECOM's enlisted Soldiers provide valuable feedback to the command's researchers on how science and technology translates into the field, Wharton said. He praised Snyder as a seasoned leader ready for the responsibility as RDECOM's senior NCO.

Command Sgt. Maj. Lebert O. Beharie (left) and Command Sgt. Maj. James P. Snyder shake hands during a change of responsibility ceremony at Aberdeen Proving Ground, Maryland, March 12, 2015. (U.S. Army photos by Conrad Johnson)

"Command Sergeant Major Snyder comes to us with great experience, and you are who we need at this time," Wharton said. "He has had a total of five years in combat. He brings to us a deep operational experience that will mix very well with our scientists and engineers."

Beharie praised his family, Army leadership, mentors and the RDECOM workforce for their support during his three decades of service.

"I do not want to focus on any initiatives or accomplishments that I may have achieved while I was here. Instead, I want to continue to say thanks," Beharie said. "My family and I are grateful and humbled by your outpouring of support.

"When I took responsibility as command sergeant major of this organization, I was impressed with the capabilities of this command as well as the patriotism of our workforce. The command touches every aspect of Soldiers' lives, from the food they eat, the clothes they wear, and everything that helps us shoot, move and communicate. We do it all here.

"I know our Soldiers will continue to enjoy the overmatch on the battlefield because of the great men and women of this command. For what you have done in the past and for what you will do in the future, I salute you."

The command sergeant major is responsible for the training, professional development, retention, readiness and discipline of Soldiers under his charge.

Snyder enlisted in 1990 and attended Basic Training at Fort Dix, New Jersey. He graduated from Advanced Individual Training at Fort Eustis, Virginia, as an AH-64 Attack Helicopter repairman.

The Army promoted Snyder to the rank of command sergeant major in 2008. In his most recent assignment, Snyder served as the command sergeant major of the 3rd Combat Aviation Brigade, 3rd Infantry Division.

Snyder has deployed to Bosnia-Herzegovina, Operation Iraqi Freedom and Operation Enduring Freedom. He has a bachelor of science from Excelsior College and an associate's degree in aeronautical studies from Embry Riddle Aeronautical University.

Read more: http://www.army.mil/article/144394

Software Proves Value in Response to Biological Incident Scenario

By ECBC Public Affairs

More than three years of work developing an integrated software system designed to respond to large-scale biological incidents came down to a recent two-week demonstration.

The U.S. Army European Command organized the Transatlantic Collaborative Resiliency Demonstration, known as TaCBRD, which consisted of two dire scenarios.

First, terrorists released anthrax spores over a wide area of a city.

Second, plague bacteria is released in a train station as crowds of people were headed to a soccer match.

The demonstration took place in Oberammergau, Germany, and Poznan, Poland, in February 2015.

"The software components were a combination of ones developed by the Chemical Biological Defense Program that we repurposed and ones that we custom-built ourselves for the project to fill in a few holes," said Bill Ginley, the Nuclear, Biological and Chemical Battlefield Integration branch chief and technical manager for the program. "We assembled them into a common architecture using a content management framework, which is similar to SharePoint. It has data sharing functions that are accessible to the entire user community."

The U.S. Army Edgewood Chemical Biological Center-led development team used digital dashboard technology to arrange decision support software applications into applications accessed from a web portal.

Public health officials from Landstuhl, Germany, a civil support team from Kaiserslautern, Germany, members of the Polish military and subject matter experts from the U.S. Environmental Protection Agency, the Department of Homeland Security and the Department of Defense worked together using the computer tools to manage the response.

After the exercise, the ECBC team members evaluated the demonstration by assembling a storyboard depicting a day-by-day timeline showing how incident responders accessed each of TaCBoaRD's tools and the actionable decisions they made.

Based on operator feedback from after action reviews, role players saw real value in TACBoaRD.

"The closest real world analogy is the Fukushima nuclear power plant meltdown after all the reporters went home," Ginley said. "The accident happened three years ago, and Japanese response crews are still working there every day to clean up the radioactive waste. We realized that we needed to come up with a system equal to the task of maintaining situational awareness for not just 72 hours, but 72 months and longer."

Read more: http://www.army.mil/article/145746

Health officials and Soldiers from Germany, Poland and the United States participate in an operational software demonstration in February 2015 designed to assist in potential responses to chemical, biological threats. (U.S. Army Photo)

Innovation, collaboration key for equipping future force

By Megan Cotton, AMC Public Affairs

HUNTSVILLE, Ala. (April 1, 2015) -- "Innovation, innovation, innovation" is the key for science and technology in order to win in a complex world, said the Army Materiel Command's Chief Technology Officer Patrick O'Neill at the AUSA Global Force Symposium.

The Army and industries' top science and technology experts met as panelists to discuss "S&T Driving Innovation for the Force 2025 and Beyond."

"Science and technology is a key enabler in order to win in a complex world, but all across S&T there is no silver bullet," said O'Neill. "AMC and [Training and Doctrine Command] are working together to enable the warfighter but the key is innovation and understanding what future needs will be."

Panelists emphasized the importance of collaboration across Army commands and industry in order to solve problems, reduce costs and increase reliability and sustainability.

"It all goes back to collaboration," said the commanding general of the U.S. Army Research, Development and Engineering Command, Maj. Gen. John Wharton. "The collaboration between the AMC depots, the lifecycle management commands, PEOs and others at the Joint Acquisition Sustainment Review brings everyone together so we collectively look at end-to-end capabilities and the lifecycle of a system."

Fellow panelist, TRADOC's commanding general for the Brigade Modernization Command, Fort Bliss, Texas, Brig. Gen. John Charlton added to Wharton's comments that prototyping technology allows for collaboration with Soldiers, receiving immediate feedback about equipment.

"There are several definitions on what innovation is; from our perspective it is the art of taking imagination, ingenuity and common sense and applying that to a problem," said Charlton. "Going through this evolutionary process leads to a better outcome. That's what rapid prototyping gives us. It gives you a chance to take feedback from the Soldier, apply it to a prototype, put it back in their hands to see how it works in an operational environment, to evaluate if you really do get a valued outcome."

Other panelists included Mary Miller, deputy assistant secretary of the Army (Research and Technology); Brian Keller, Army strategic account executive, Leidos, Inc.; Patrick O'Neill, Army Materiel Command's chief technology officer; and Retired Col. Donald Kotchman, vice president, Tracked Combat Vehicles, General Dynamics Land Systems. Retired Lt. Gen. Jeffery Sorenson, president, A.T. Kearney Public Sector and Defense Services, LLC served as panel moderator.

Read more: http://www.army.mil/article/145656

Deliver More Capability to the Fight

By David Vergun, Army News Service

Dr. Jeffery Holland, director of the U.S. Army Engineer Research and Development Center and chief scientist for the U.S. Army Corps of Engineers, speaks during a National Defense Industrial Association-sponsored Engineered Resilient Systems, or ERS seminar in Springfield, Virginia, March 25, 2015. (U.S. Army photo by David Vergun)

The Army is now using high-performance computer modeling and simulation to ensure its weapons platforms and systems deliver greater effectiveness to the warfighters, said Dr. Jeffery Holland, director of U.S. Army Engineer Research and Development Center.

Holland, who is also chief scientist for the U.S. Army Corps of Engineers, spoke at a National Defense Industrial Association-sponsored Engineered Resilient Systems, or ERS seminar here, March 25.

Weapons platforms, like trucks and aircraft and all their internal components, are being subject to more rigorous testing throughout the design phase, and even after production, using supercomputers to model and simulate all kinds of extreme conditions, Holland said.

The supercomputers are really good at digesting huge chunks of data using many variables that simulate such things as dust, humidity, shock and vibration, materiel fatigue over time and so on, he said.

Once that is all digested, the supercomputer spits out its analysis of that data, often within mere seconds, he said, providing an easy-to-understand picture of failure and friction points between systems or between components within systems.

Different types of software programs can even massage the data to produce analysis of alternative designs, cost-benefit analysis, link analysis, risk assessments and so forth.

The supercomputer might come up with two billion design alternatives and then narrow that down to the 10 most optimal. Analysts will then not need to question whether or not something is optimal, but why it is optimal, he said.

In Army-speak, the "why" question might be that such and such a design will make the system more (or less) lethal, survivable, mobile and so on. Optimal component designs will have tradeoffs, meaning something can go faster, but it might require less heavy protective armor to do that, he said.

Those trades inform Army decision makers so they can make better decisions for the warfighter in a budget-constrained environment, he said.

Read more: http://www.army.mil/article/145167

RDECOM Charts the Way Ahead for Systems Engineering

Thomas Haduch

Program managers, the U.S. Army Research, Development and Engineering Command; and life cycle sustainment commands are responsible for Army weapon systems management from inception to retirement.

Product Lifecycle Management, or PLM, encompasses development, engineering, manufacturing, test and logistics activities—all of which require creation of and access to a large set of data about a product.

Product Data Management, or PDM, is the business function within PLM that is responsible for the creation, management and publication of and access to product data.

The process provides a central knowledge repository for process and product history, and promotes integration and data exchange among project managers, engineers, quality assurance and sustainment teams. This ensures everyone is on the same page by using a single, authoritative set of product data, with high standards of quality control for accuracy and currency throughout a product's life cycle.

Enterprise Product Data Management, or ePDM, is an Army initiative to create the infrastructure needed to manage all the information related to a product across the life cycle and the product's multiple stakeholders.

The goal is to integrate people, data, tools, processes and organizational systems by providing product data that can be shared across the Army enterprise. The ePDM will help program managers reduce time to fielding, improve quality through the use of digital data and modeling tools, foster prototyping, track and predict costs and help transition technology opportunities.

The Army seeks to develop technology solutions that meet the requirements of a complex world. But complexity breeds more complexity, resulting in new system designs, which are more difficult to develop, build, manage and maintain because of system requirements for interoperability and the ability to operate in complicated system of system environments.

Currently, product data are stove-piped, expensive and time consuming to manage and maintain because data are stored across multiple organizations in disparate systems, which still include paper documentation and 2-D drawings. Through a systems engineering approach, the Army is analyzing its data processes and requirements to optimize data sharing methods, reduce costs and manage risk through the use of an Army-wide ePDM approach.

Imagine a future communications device in the hands of Soldiers in the field. The product will have gone through an intensive research and development phase, collaboration with industry for product development and production and fielding to sustainment upgrade capability support. Each step of the development requires engineering data, such as CAD models, technical drawings, specifications, design analyses, test data and more. This makes the need critical for an ePDM based enterprise approach as part of the systems engineering process.

In the future, the data about every component of weapon systems will be managed by an ePDM approach that holistically captures the system throughout its life cycle. RDECOM's ePDM goal is to provide mission system support to the U.S. Army Materiel Command engineering and logistics communities with a single authoritative and agile enterprise system.

The ePDM capability supports science and technology, systems engineering, system development, and acquisition logistics business needs, to include:

- Technology assessment/development
- Prototype integration
- Modeling and simulation
- Design
- Configuration management
- Trade studies
- Logistics support analysis

By introducing consistency, the ePDM will keep projects on track from research and development to fielding throughout the project lifecycle. The ePDM will also provide needed engineering product data to downstream business systems such as the Logistics Modernization Program to provide more integration between engineering and logistics business processes.

In March 2014, RDECOM formed a working group to discuss and determine the product data business processes that require cost effective and enterprise-wide implementation and how to best achieve the planned goals. We hope these efforts will ensure RDECOM engineering data system owners have a voice in defining the engineering product data business processes to be included in the AMC solution.

The ePDM has a bright future at RDECOM as the command continues to provide outstanding engineering support to our Soldiers. The chief systems engineers from across the command and I are collaborating on developing a strategy of enterprise practices, training and tools intended to achieve a degree of consistency in how systems engineering is applied to all technology development projects. At the same time, we will focus on ensuring the decisions, instructions and tools add value, not hinder innovation. ■

Editor's note: The RDECOM PDM Working Group contributed to this column.

ARMY EDUCATIONAL OUTREACH PROGRAM

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STRENGTH OF THE NATION

OSIE DAVID

COMMUNICATIONS-ELECTRONICS RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Dismounted Soldiers operate in the type of complex, dynamic environments where access to real-time actionable intelligence is often most needed and least available. Delivering critical information in a timely manner and in an effective format is a technical and systemic challenge that until recently was just not possible.

Osie David, a CERDEC computer scientist, led the program for the Army's initiative to enable mission command and actionable intelligence for company-level Soldiers and below. The three-year program successfully concludes this year delivering a baseline architecture and a suite of applications and handheld capabilities to provide Soldiers unprecedented situational awareness and actionable intelligence.

"The solution goes beyond empowering the individual Soldier," David said. "It allows the Army to integrate a suite of tools and capabilities across a broad set of requirements, and to give those capabilities to a Soldier formation to enhance its collective effect."

Read the full article on page 14.