Spc. Haley Haye and Sgt. Leonalyn Barnes, assigned to the 5th Squadron, 4th Cavalry Regiment, 2nd Armored Brigade Combat Team, 1st Infantry Division, perform maintenance on an M3 Bradley fighting vehicle to prepare for a tactical movement in Grafenwoehr, Germany, on April 21, 2018. (Photo by Staff Sgt. Julie Jaeger)

Machines Don't Have to Break

■ By Col. David Robinson

Defense Innovation Unit Experimental is helping the Department of Defense achieve the financial and readiness improvements available through artificial intelligence.

New sustainment and logistics tools can have a significant impact on readiness, which is the Chief of Staff of the Army's focus. In the Bradley fighting vehicle fleet alone, an improvement in sustainment efficiency can deliver billions of dollars in savings and, more importantly, improve readiness rates substantially.

Defense Innovation Unit Experimental (DIUx) is helping the Army's sustainment and acquisition communities by bringing advanced commercial artificial intelligence (AI) tools to bear against readiness challenges in the Bradley fighting vehicle fleet.

A Department of Defense (DOD) entity that reports to the Secretary of Defense, DIUx seeks to rapidly bring stable commercial technologies to warfighter problem areas. From its headquarters in Silicon Valley and offices in Boston; Austin, Texas; and the Pentagon, DIUx supports all components across each of the services and the intelligence community.

DIUx already has active predictive maintenance agreements serving Air Force programs for the E-3 airborne warning and control system (AWACS), C-5 Galaxy aircraft, and the F-16 fighter aircraft and will soon have an agreement for the F-35 fighter aircraft. Adding a similar project in support of the Army's Product Manager Bradley Fighting Vehicles was a natural next step.

AI on Predictive Maintenance

Commercial enterprises are increasingly making use of the financial and readiness improvements that predictive maintenance technologies make possible. A recent study indicated that data-enabled efficiency is expected to contribute $15 trillion to the U.S. gross domestic product by 2030.

DIUx has made a specialty of using those commercial business case dynamics to fuel innovation that can be put to work for the warfighter now—the emphasis being on now, and the imperative being commercial.

The DOD cannot continue to pay for all the technical innovations it needs; it must find new ways to access nontraditional participants and the efficiencies that the free market drives.

A recent case study by Uptake Technologies Inc. shows that for a North American Class I railroad, including over 600 assets monitored, AI created approximately $160,000 in value per locomotive per year for an annual savings of $100 million. This shows that the more complex the system, the more likely that cost savings and real efficiencies in sustainment and logistics will occur through proper application of AI.

The Bradley fighting vehicle is a complex system. Initial AI work on its primary systems, such as the engine, transmission, and brakes, will deliver similar potential for readiness improvements as commercial industries are achieving through their own AI efforts.

In the Army, it is estimated that as little as 1 percent of available sustainment data is being mined to inform proactive and predictive maintenance. Considering that only a tiny fraction of weapon systems maintenance data is being studied by advanced AI algorithms, this sparse penetration of AI in the sustainment community makes the benefits of a concerted program all the more compelling.

Now Fix It!

One of the most promising elements of AI in the sustainment realm is the ability to use it to make repairs when inevitable failures occur. In the future, the Army will operate on a complex and austere battlefield that will take its toll no matter how robust the sustainment preparation or how efficient the failure assessment. At some point, our machines will break, but AI delivers the potential to enable lower level, farther forward repairs.

If we can make AI a primary component of repair and allow it to assist operators with conducting maintenance, the Army will see a marked improvement in readiness rates as weapon systems return to service more quickly, farther forward. The work that the Army Futures Command and its Synthetic Training En-

vironment Cross-Functional Team (CFT) are doing makes such innovative solutions possible.

The techniques employed are known as guided artificial intelligence for troubleshooting. They leverage the AI functionality inherent in Bayesian networks. For any given system, these techniques take the wisdom of both the original equipment manufacturer and the most experienced Army maintainers and have it available to the forward operator in a virtual environment.

Even in times of network disconnectedness, the operator could query all available data on a given fault to find a remedy, or the operator could accurately diagnose problems for higher level maintainers to address. The results are savings of time and money and increased safety and readiness. This potential is already being realized in communications and electronics systems on board complex Army weapons systems.

The Army Readiness Imperative

The E-3 AWACS predictive maintenance prototype has demonstrated the potential for both $186 million in maintenance savings across only a small fleet of aircraft, as well as improved readiness rates. Application across much larger programs of record, such as the C-5, F-16, F-35, and Bradleys, are likely to yield an even greater potential for increased warfighter readiness and taxpayer savings. Better still is that AI tools such as these are in direct support of the Futures Command CFTs as core enablers.

The Long Range Precision Fires, Air and Missile Defense, and Next Generation Combat Vehicle CFTs are all direct benefactors of AI tools in core systems. The Network, Position Navigation and Timing, and Future Vertical Lift CFTs are likewise affected by AI prospects and are current DIUx customers.

DIUx employs an acquisition mechanism called commercial solutions opening, a streamlined version of the "other transaction" mechanism, through the Army Contracting Command–New Jersey. Both the commercial solutions opening and other transaction mechanisms allow the DOD to partner with commercial entities with whom it normally would not interact.

They provide flexibility to address areas such as intellectual property and payment milestones that are important to commercial entities. These mechanisms provide speed of acquisition and contractual flexibility that other acquisition mechanisms simply cannot match.

Bradley Predictive Maintenance

From the first solicitation posting to the beginning of prototype work, DIUx, the Product Manager Bradley Fighting Vehicles, and the Army Contracting Command–New Jersey moved collaboratively through a roughly 90-day sequence to award a contract for Bradley Fighting Vehicle Predictive Maintenance. Within this time, DIUx ensured the solicitation sequence properly represented warfighter needs, surveyed the commercial AI vendor marketplace for solutions, and identified several options to consider.

The Bradley Fighting Vehicle Predictive Maintenance Program is being executed by a true multicomponent, multiservice DIUx team, which includes activated Reserve Soldiers from the 75th Innovation Command, National Guardsmen, and Air Force reservists.

The initial program is occurring in four phases. First, there is the enormous task of moving data to an accessible location to apply algorithms. The Air Force E-3 AWACS program gained access to very rudimentary data, including handwritten pilot logs. The more normalized the data, the more efficient this first step will be.

The better the input data, the more extensive its history and the more normalized for AI, and thus the larger the effect a converted AI program will have on predictive maintenance. Phases two through four will involve assessing the data, constructing a pilot trial product, and evaluating that trial product to inform the next round of data collection.

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While the mix of technologies and skills it employs may vary depending on the problem at hand, DIUx was created with a simple imperative, which the Army G-4, Lt. Gen. Aundre Piggee, summarized well: "Put today's technology in the Army, today."

The logical question is where to go next with this potential. How can we harness the immediate effect of a concerted effort to infuse AI into programs of record and move them from a proven prototype to a steady state?

From business processes to maintenance efficiencies, innovation is occurring across the Army, and DIUx will continue to accelerate the use of commercial development to address warfighter problems. The future battlefield is upon us, and we now have an unprecedented ability to incorporate commercial innovation into the sustainment mission and our readiness imperative.

Col. David Robinson is the acting military director of DIUx. He was commissioned as a Signal Corps officer and holds a master's degree in space systems operations management from Webster University and an MBA from the University of Delaware.