Spinning Out Future Force Technologies to Warfighters Today

Dr. Richard E. McClelland

Today's Soldiers are at the forefront of the Army's transformation to a more agile, lethal and modular force. The U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) is making great strides toward Future Force transition, working diligently to provide Soldiers with technologies they need now to make them a lighter, reconfigurable and more deployable force. Revolutionizing warfare through the spin-out insertion of Future Force technologies into current systems will enhance combatant commanders' mobility, survivability, maneuverability and lethality during all potential battlefield operations. TARDEC's top priority programs are leading the Future Combat Systems (FCS)-equipped Unit of Action (UA) vehicle development while infusing technology into the Current Force.

TARDEC's APS has demonstrated that an integrated survivability system on ground combat vehicles can reduce a vehicle's weight while greatly increasing the vehicle's survivability. Here, a 25th Infantry Division Soldier provides overwatch from his Stryker vehicle near Sinjar, Iraq. (U.S. Army photo by Jory Randall.)

TARDEC is organizationally a part of the Army's Research, Development and Engineering Command (RDECOM). TARDEC is also collocated with, and functionally an integral part of, the U.S. Army Tank-automotive and Armaments Command Life Cycle Management Command in Warren, MI. To be effective, TARDEC must have extensive knowledge of all component technologies that are viable for Soldiers. TARDEC has structured its Future Force development around platform-specific technologies in mobility, power and energy (P&E), survivability, intelligent systems, and maneuver sustainment and support, using robust experimentation and evaluation to prove revolutionary concepts, mature architecture and components.

Enhancing Track Mobility

TARDEC has focused on providing Soldiers with advanced lightweight power systems that meet Future Force combat vehicle requirements. From our Track Improvement Program to high-power engine research, TARDEC's mobility team is improving the Current Force while building toward the future.

Since 2004, TARDEC has been working improvements to the Bradley Fighting Vehicle's (BFV) T-157 track system. During testing at Yuma Proving Ground (YPG), AZ, TARDEC found the track system's life span to be 2,400 miles. Yet in Iraq, the same track system was only lasting 400 miles before failure. TARDEC took action by determining through Soldier reports the sources of the failure, which were extremely hot summer temperatures in Iraq, operational use at high speeds on pavement and the vehicle's weight — all of which are outside current Army design parameters. The T-157 was designed for a maximum 25-ton weight limit, yet the current BFV is operating around 36 tons.

TARDEC teamed with industry to develop a new, modernized track system weighing 400 pounds less than the previous track with a 5,000-mile life span. After completing tests at YPG, TARDEC anticipates that the new track system will enter production in 2006.

TARDEC is developing a segmented band track and new lightweight, high-strength steel track system by taking prior track improvement initiatives and looking at Future Force requirements. The segmented band track is easy to install and encompasses the lightweight and high-speed performance of continuous band track technology. The steel track will be developed through the use of high-strength alloy materials and current computerized design tactics for risk mitigation. Together, these modernized track designs will relieve much of the track "repair and replace" burden while also meeting Future Force requirements.

TARDEC is leading the way in track developments that will encompass a new segmented band track and a new lightweight, high-strength steel track system to fulfill FCS manned ground vehicle requirements. The new lightweight track will have the high-speed performance advantages of continuous band track technology. (Photo and diagram courtesy of TARDEC.)

Referring to TARDEC's AP program, Soldiers from the 29th Infantry Regiment, Fort Benning, GA, commented, "This system is great. I wish I had it on my BFV now. Every vehicle needs this system because it improves our chances on the battlefield. The vehicles can spread out and become secure." (U.S. Army photo courtesy of TARDEC.)

Boosting Power Density

TARDEC is also advocating engine technology developments for military vehicle applications because of the increase in power density requirements for the Future Force. Three FCS engine candidates have been supported since the FCS program's start, and selection will likely be made later this fiscal year. TARDEC's FCS Engine Development Advanced Technology Objective (ATO) has designed engines that double the power density of what is currently available from commercial-off-the-shelf engines, concurrently reducing the engine's weight, size and heat rejection. This objective isn't just focused on engine improvements — it looks at the vehicle's entire propulsion system including air filtration, cooling, exhaust and thermal management, turbo-charging, fuel economy and onboard fuel requirements.

But it doesn't stop there. The diesel engine, amazingly, has much more room for improvement. The High Power Engine Research (HIPER) ATO focuses on technologies that significantly increase and improve power density. Under this development, TARDEC will pinpoint investigations on high-speed diesel engine combustion research for applications into future manned and unmanned ground combat vehicles. Concentrating on advanced high-pressure fuel injection systems, TARDEC plans to increase engine speed and power by 50 percent.

TARDEC is also testing prototypes of a modular opposed piston — and an opposed cylinder 2-stroke diesel engine as a second initiative under this development. This effort encompasses the design, fabrication and testing of a ground vehicle engine that will increase power density with a 30-percent reduction in heat rejection and weight because the engine is not equipped with cylinder heads or a valve train. TARDEC will be performing combustion research to maximize air utilization for the cylinder's unique geometry.

P&E

Military requirements demand a 30- to 50-percent reduction in power systems volume. TARDEC is striving to meet the requirement through extensive research in hybrid electric and fuel cell technologies. TARDEC's Hybrid Electric FCS Increment II ATO improves weight, size, operational temperature and efficiency for Future Force vehicles. TARDEC is researching individual

system components including batteries, converters/inverters, controllers, motors, generators and thermal management systems. The greatly improved hybrid electric system will enable silent operation and mobility as well as enhance dash speed and battlefield robustness while reducing acoustic, thermal, visual and electromagnetic interference signatures.

TARDEC has developed a P&E Dynamic Test Rig (DTR), which will also be known as a Dynamic System Integration Laboratory. The DTR is a mobile platform that can qualify advanced hybrid electric power components and subsystems to the point where they are ready to meet performance objectives in relative environments. This 20-ton hybrid-electric-powered track combat vehicle demonstrator allows for the interchangeability of hybrid electric components. TARDEC has added access hatches, internal mounting structures for test articles and a sophisticated data acquisition system to the platform. The DTR will increase a technology's readiness level by showing that hybrid electric propulsion system components can withstand meticulous testing under rugged environmental conditions. These tests simulate real-world scenarios while operating on test tracks, cross-country terrain and paved roads.

TARDEC's Hybrid Electric FCS Increment II ATO improves weight, size, operational temperature and efficiency for Future Force vehicles.

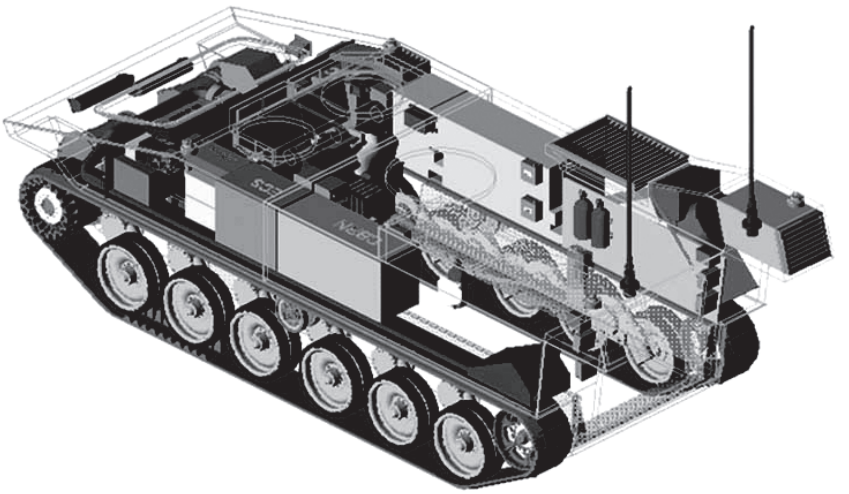
Increasing Survivability

"Don't be seen, hit, penetrated and killed," is TARDEC's leveled approach to increase Soldier and vehicle survivability for Current and Future Forces. TARDEC is leading the Army's Integrated Survivability Advanced Technology Demonstration (ATD), a program that has successfully saved the lives of Soldiers in theater through armor solutions and ensures future survivability through advanced techniques such as active protection (AP).

RDECOM has looked into AP efforts on both close-in and extended threats, as well as chemical energy (CE) and kinetic energy (KE) threats. These survivability technologies are based on both electronic and mechanical threat-defeat approaches. RDECOM has effectively developed and demonstrated AP systems (APS) that have the ability to defeat rocket-propelled grenades (RPGs), CE threats, direct-fired mortars and similar projectiles prior to the projectile defeating the vehicle.

Teaming with industry, TARDEC's Integrated Army Active Protection System (IAAPS) Mature On-the-Move threat-defeat testing sequence is undergoing a series of threat testing against RPGs at YPG. Six threat categories have been successfully completed, including two on-the-move threat defeats. IAAPS is an integrated survivability suite that is outfitted in lightweight armor and is equipped with various sensors, processors and countermeasures. The APS has demonstrated that an integrated survivability system on ground combat vehicles can reduce a vehicle's weight while greatly increasing the vehicle's survivability.

In addition to the Integrated Survivability ATD, RDECOM is developing a tank-fired KE AP (KEAP) system as an FCS solution to KE threats. Currently, APSs only address CE threats, and this program will upgrade and possibly replace some CE APS components to provide military platforms with the countermeasures necessary to defeat and survive KE threats. This effort is a collaboration among TARDEC; the U.S Army Research Laboratory; U.S. Army Armament Research, Development and Engineering Center; and U.S. Army Aviation and Missile Research, Development and Engineering Center (AMRDEC). The team has built and tested countermeasures with the capacity to deflect and defeat a tank-fired KE threat through the integration of accurate passive sensors and radars. The KEAP system will be matured to defeat all



The DTR is a mobile platform that can qualify advanced hybrid electric power components and subsystems to the point where they are ready to meet performance objectives in relative environments. This platform will increase a technology's readiness level by showing that the components of a hybrid electric propulsion system can withstand meticulous testing in rugged environmental conditions. (Image courtesy of TARDEC.)

AMRDEC has successfully demonstrated a close-in APS as an outgrowth of its efforts in counteractive protection for U.S. missiles. This system is undergoing testing on a TARDEC Stryker vehicle. (U.S. Army photo courtesy of *Soldiers Magazine*.)

large caliber tank-fired threats and transitioned into the UA program development as early as FY07.

It's no secret that the Army's current fleet could use enhanced RPG protection now. RDECOM is maturing candidates while the Army solicits for engineering development and rapid fielding. A market survey done earlier by TARDEC identified as many as 15 separate developments worldwide with potential to respond. RDECOM is supporting an important subset. AMRDEC has successfully demonstrated a close-in APS as an outgrowth of its efforts in counteractive protection for U.S. missiles. This system is undergoing testing on a Stryker vehicle. TARDEC has supported a system called Full-spectrum AP Close-in Layered Shield, which is undergoing end-to-end system-level tests. In all, RDECOM is supporting four of the candidate systems and must soon select one for development. Our Soldiers need it now.

Working with the Program Executive Office for Combat Support and Combat Service Support, and capitalizing on current add-on armor successes, a new armor strategy has been adopted. The Advanced Lightweight Vehicle Armor Protection ATO is running alongside a Long-Term Armor Strategy, an effort to armor every tactical-wheeled vehicle. The TARDEC ATO seeks to improve vehicle armor protection levels while greatly reducing the armor's size and weight. This will increase battlefield survivability for Current and Future Force vehicles through the development of highly efficient integral, ceramic and advanced electromagnetic armor solutions. Coupling the armor with lightweight structural materials that have novel defeat-absorbing mechanisms, the Army will be able to increase vehicle survivability against RPGs, heavy machine guns and medium-caliber cannon threats, while reducing an armored vehicle's weight. A key ATO focus will be developing a lightweight armor solution that can be applied to a wide range of tactical vehicles, maximizing commonality among all structural components.

Maneuver Sustainment and Support

TARDEC is seeking to reduce water and petroleum logistical burdens in theater. Breakthrough research has been underway to successfully integrate water generation systems onto various military platforms, giving Soldiers purified water while deployed in remote locations. Army requirements show that a Soldier operating in extreme heat environments needs 1-3 gallons of water per day to prevent dehydration. Adding personal hygiene, combat meal preparation and emergency medical treatment to the mix, one Soldier may need up to 6.6 gallons of water per day. Without advancements in water sustainment technology, water distribution is anticipated to account for 30-40 percent of the UA daily sustainment requirement and logistics burden.

TARDEC is exploring two distinctive systems: Water Recovery Unit from Exhaust (WRUE) and Water Recovery Unit from Air (WRUA). TARDEC's WRUA system produces potable water from air and will be proficient enough to generate potable water in an operating environment of 20-120 degrees Fahrenheit ambient temperatures and 20-100 percent relative humidity, with

a minimum dew-point temperature of 20 degrees Fahrenheit, while supplying purified water for up to 12 Soldiers at a time. During FY06, TARDEC plans to demonstrate water recovery units on Heavy Expanded Mobility Trucks, Family of Medium Tactical Vehicles and Humvees, and both the standalone system and the vehicle-integrated system will be ready for military vehicle integration by 2007.

The WRUE has the capability to generate drinking water by capturing water from fuel expended by engines on the battlefield. This system can be embedded into current and future military platforms and will also feature low energy and lightweight devices that have the ability to purify water on combat platforms.

For each gallon of fuel that is consumed by the vehicle, a half-gallon of drinkable water is recovered for the Soldier. The WRUE system will enable warfighters to operate without an external resupply of water for an extended period.

Military bridging is also a major UA concern. TARDEC's Bridging Simulation Laboratory, located at Selfridge Air National Guard Base, MI, features computer-controlled load test areas that are equipped with automated data acquisition capabilities for structural testing of bridging systems. Both static and dynamic structural load applications are available for structural and fatigue tests.

TARDEC is testing advanced composite materials to see how useful they will be for building a tactical bridge. Under the Advanced Modular Composite Bridge program, TARDEC will determine if the composite material solutions are capable of bridging gaps of 13, 20 and/or 26 meters for Future Force applications. TARDEC is working with the threshold load of a fully loaded Future Tactical Truck System (FTTS) towing an FTTS trailer with a mission load class of 45-70 tons. This initiative is a direct follow-on program of the highly successful Composite Army Bridge and the Modular Composite Bridge programs. The Defense Advanced Research Projects Agency is a major contributor to this effort.

TARDEC's ability to rapidly respond to the immediate needs of Soldiers in theater is an organizational characteristic. TARDEC has fielded life-saving solutions to Soldiers while continuing to develop robust Future Force programs.

While the United States enters a new century of warfighting, TARDEC is ensuring that we understand and meet our Armed Forces' needs and expectations. When Soldiers make suggestions, TARDEC listens. When the Army calls, we respond. As the Army transforms into a more modular, stabilized and flexible force, TARDEC, with more than 50 years of experience, is leading the way — relevant and ready – developing superior technology for a superior Army.

DR. RICHARD E. MCCLELLAND is the TARDEC Director, Detroit Arsenal, Warren, MI. He has a B.S. from the U.S. Military Academy, an M.S. in mechanical engineering from Ohio State University and a Ph.D. in engineering from the University of Detroit. He served 11 years on active duty with the Army and has worked at the Detroit Arsenal since 1975. McClelland is a Level III certified Army Acquisition Corps member.

Robots at War — Revolutionary Warfare Supporting the Homeland and Abroad

Ashley John

Robots are playing a revolutionary role on the battlefield as the Army continues to fight the global war on terrorism (GWOT). Keeping Soldiers out of harm's way by using unmanned systems has become an operational requirement that has transitioned from original Future Force applications into Current Force operations. From small robots that inspect the underside of vehicles to 20-ton robots that have the capability to engage threats, the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) is at the forefront of developing unmanned systems to ensure that the Current Force is lighter, reconfigurable and increasingly deployable against enemy threats both on U.S. soil and abroad.

The GWOT has forced advanced robotics program technology to be spun into current operations. This has resulted in an onslaught of robotics technology quickly reaching the hands of warfighters at home and abroad.