Electrifying the Arsenal

Army's National Automotive Center Teams with United Defense on Hybrid-Electric Vehicle

CARL JOHNSON

A triangular yellow sign hangs in the maintenance bay amidst the hulking Abrams tanks being serviced at Fort Hood, Texas. The sign reads, *Caution: Noise Hazard Area.* Good advice, since the intense heat and high-pitched scream emanating from the turbine-driven diesel engines that propel these 70-ton behemoths can melt glass and will deafen unprotected ears.

But that level of noise and heat emissions will soon be a thing of the past. A new kind of armored vehicle propulsion system is being developed by the U.S. Army Tank-automotive Research, Development and Engineering Center's National Automotive Center (NAC) and its industry partner, United Defense (UD). An innovative application of both mature and new technologies, the new propulsion system keeps noise and heat emissions low and vehicle performance high.

Army — Industry Teaming

The Army's goal is to field a lean, modern, and efficient military ground vehicle fleet. Key to that goal is exploiting the economic benefits of cooperative development programs with industry. The NAC supports the Army's goal by identifying opportunities to partner military, commercial, and academic entities in cost-sharing programs that focus and accelerate the development of technologies, thereby enhancing automotive performance. Such partnerships avoid the expense of a unique military program by structuring these technology development programs to provide benefits for both defense and commercial industry.

A key advantage of the system is its ability to perform in an all-electric mode without use of the engine in the PPU [prime power unit]. The result is the near-silent movement of a 15-ton combat vehicle and a greatly reduced heat signature.

Such cooperation is achieved because both parties will profit in acquiring technologies enhancing the automotive performance of their mobility platforms. The Army will acquire ground vehicles that have increased performance with decreased Life Cycle Cost. Industry will accrue the same performance benefits and be competitive in the commercial market.

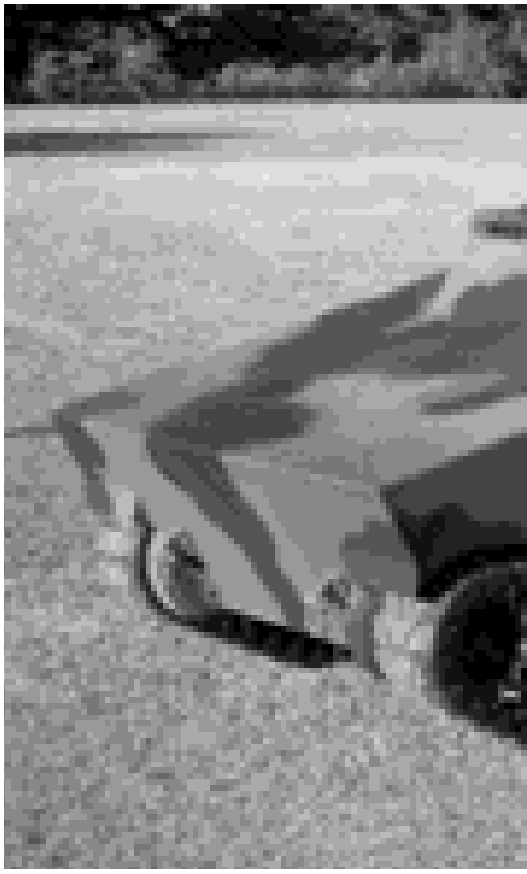

Photo Courtesy United Defense

Goal — A Hybrid Fleet

For this partner project, the target technology is hybrid electric propulsion — a combination of a conventional engine, generator, a battery pack, and electric-drive motors. While the automotive industry has developed viable hybrid electric designs for passenger cars and light transports, UD has the technology in place to make the first hybrid-drive ar-

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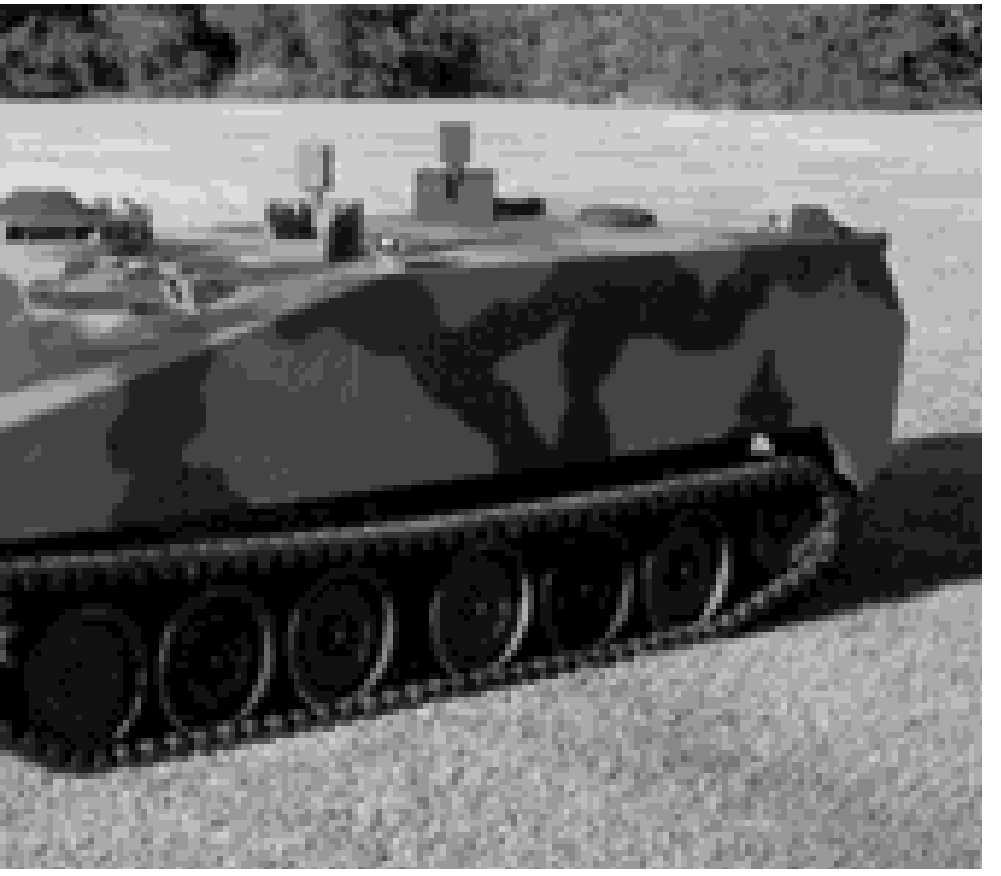
mored combat vehicle available for mass production in as little as two years.

UD and NAC have already built a hybrid-drive demonstrator vehicle that was on display in October 2000 at the annual Association of the U.S. Army (AUSA) Convention in Washington, D.C. The overall purpose of this demonstrator is to showcase supporting technologies that are essential for the Army's Future Combat System as well as to demonstrate that some of these advanced automotive technologies are ready for near-term implementation in existing systems.



Hybrid-drive demonstrator vehicle. United Defense and the National Automotive Center put the vehicle on display in October 2000 at the AUSA Convention in Washington, D.C. United Defense has the technology in place to make the first hybrid-drive armored combat vehicle available for mass production in as little as two years.

The demonstrator started with an M113 armored personnel carrier chassis. Beyond that, it has little in common with its venerable forebears. "This vehicle is the culmination of nearly 30 years of research and development by UD in electric-drive science and human factors," said Elmer Doty, vice president and general manager of United Defense's Steel Products Division. "These technologies are much closer to production than most people understand, and it's happening at exactly the right time for the Army."

The Moving Parts

The centerpiece technology of the demonstrator is the propulsion system. Its primary components are two 250hp oil-cooled electric motors to drive the sprockets, a battery pack for energy storage, and a diesel-powered, engine-driven generator housed in the prime power unit (PPU).

The system operates as a true hybrid. When the vehicle is being accelerated, the battery pack and the engine-driven generator simultaneously provide power. When the vehicle is operating at "normal" speeds, the PPU is providing the "average" electric power needed to drive the track sprockets and auxiliary equipment. The batteries will be used as a supplemental source for transient power needs such as accelerating, steering and climbing, and to store the energy produced when the brakes are applied on the vehicle.

The PPU will keep the battery pack at a nearly constant state-of-charge over the course of a normal mission. By using batteries to supply the transient peak power demands, the engine can be built much smaller than that required for a conventional combat vehicle.

True Stealth Mode

A key advantage of the system is its ability to perform in an all-electric mode without use of the engine in the PPU. The result is the near-silent movement of a 15-ton combat vehicle and a greatly reduced heat signature. The system is equipped with a temperature-modulated, electrically driven cooling fan that significantly reduces noise and power consumption under normal operating conditions and ambient temperatures.

The demonstrator, as configured, is capable of about 10 miles of silent all-electric propulsion. If stationary, it could perform in an extended "silent watch" mode for 24 hours or more depending on the equipment installed. Alternatively, when stationary, the vehicle can generate about 200kw of electricity and function as an auxiliary power unit to power lights and other electrical equipment for troops in the field.

Performance and Payload

In addition to all this operational capability, vehicle performance and power actually increase. Relative to the M113A3, its closest conventional cousin, this vehicle will produce nearly 500hp in acceleration vs. 275hp for the M113A3. This 500hp burst is achieved by supplementing the conventional engine's generated power with the energy stored in the battery pack. Conversely, the use of a "small" engine constantly running at its "sweet spot" will provide a doubling in fuel economy, thereby increasing range of travel and reducing logistics requirements.

The nature of the hybrid electric power train allows maximum interior space for payload. Since the front of the vehicle has no power pack, the driver and commander sit roughly side by side for better coordination. The sloped front of the vehicle also improves visibility, signature, and survivability. The lengthened hull results in a larger and more efficient interior for troops and cargo.

Given the redesign opportunity, UD has also enhanced the ergonomics of the seating and instrument panel. And for the troops, they've added a combination integral air conditioner, heat pump, and several 110V outlets for such modern battlefield necessities as laptops and cell phones.

Treading Softly

Another feature of this demonstration vehicle is a one-piece rubber "band" track. Molded from high performance rubber with bonded steel reinforcement, this track has been developed and extensively tested in cooperation with the Army, UD, and its partner company — Soucy, Inc., of Canada, manufacturers of industrial rubber products. For the 15- to 20-ton weight class, it offers increased durability, reduced weight, reduced heat and noise, and a vastly improved ride when compared to conventional steel track. And the fact that its design features a one-piece assembly reduces the track maintenance costs.

Tracking the Future

The hybrid-electric drive demonstrator clearly was a big hit at the AUSA Convention. The lighter weight, the modularity, and the stealth of the design seem to align perfectly with the Army's transformation vision, which was the theme of the conference.

Adding to the viability of the program is the cost. "In production, the power train and track shown on this demonstrator could conceivably cost about the same as the subsystems they would be replacing," says Doty. "Vastly improved performance, reduced life cycle costs, and a reduced logistics burden — this is exactly the kind of innovation the Army is looking to us to provide right now."

The NAC, in partnership with UD, has developed a demonstrator that is clearly the direction of future powertrains. This partnership, supported by other NAC partners, will help guarantee that the Army's soldiers are equipped with the best technology in the world today and well into the future.

Editor's Note: For questions or comments on this article, contact Margaret Compton, U.S. Army Tank-automotive and Armaments Command Public Affairs, at **comptonm@tacom.army.mil.**

List of Top 100 Defense Contractors Now Available

The Department of Defense announced today [Jan. 24, 2001] that the fiscal year 2000 listing of the 100 companies receiving the largest dollar volume of prime contract awards is now available on the Web at **http://web1.whs.osd.mil/peidhome/procstat/p01/fy2000/top100.htm** .

The top ten defense contractors for fiscal year 2000 and the dollar value (in billions) of their prime contracts are as follows:

- Lockheed Martin Corp. ($15.1)
- The Boeing Co. ($12.0)
- Raytheon Corp. ($6.3)
- General Dynamics Corp. ($4.1)
- Northrop Grumman Corp. ($3.1)
- Litton Industries Inc. ($2.7)
- United Technologies Corp. ($2.1)
- TRW Inc. ($2.0)
- General Electric Co. ($1.6)
- Science Applications International Corp. ($1.5)

Editor's Note: This DoD Press Advisory is in the public domain at **http://www.defenselink.mil/news/.**

DoD Releases Industrial Capabilities Report to Congress

The Department of Defense "Annual Industrial Capabilities Report to Congress" is now available on the Web at **http://www.acq.osd.mil/ia/**.The report is required by section 2504 of Title 10, U.S. Code, to be delivered to the Senate and House Armed Services Committees by March 1st of each year.

This year's report emphasizes that DoD's ability to execute its national defense strategy is predicated on its ability to access a supplier base that can: 1) design and produce next-generation weapons; 2) innovate to preserve technological leadership; 3) reduce cycle times to respond to evolving threats; 4) lower costs; and 5) support interoperability for joint and combined operations with coalition partners.

The report also states that the competitive pressure on the marketplace is the best vehicle to shape an industrial environment that supports the defense strategy.

Editor's Note: This DoD Press Advisory, published Jan. 23, 2001, is in the public domain at **http://www.defenselink.mil/news/.**