NEWS

U.S. Military Goes For Hybrid Vehicles

Experimental Marine Corps armored vehicle has diesel-electric drivetrain

SHADOW: Meant to be stealthy as well as fuel-efficient, this armored vehicle being developed for the Pentagon would have a hybrid drivetrain, combining a combustion engine and battery-powered traction.

It's not hard to see why the U.S. military sees hybrid vehicles as the wave of the future. Combining a combustion engine with electric traction takes a vehicle farther on a fill-up, and this is particularly so for the heavy-duty diesel guzzlers used by the military.

Even more significant are the performance advantages. Hybrids can double as portable generators to power everything from onboard sensors and targeting devices to mobile hospitals. They accelerate faster than combustion-only machines. And they can all but vanish from heat-sensing infrared scopes by silencing their engines and switching to battery power.

Army special-operations soldiers and a Marine reconnaissance team just spent two weeks in the Arizona desert testing the most sophisticated hybrid demonstration vehicle to date—the U.S. Marine Corps's Reconnaissance Surveillance Targeting Vehicle (RST-V). It's a four-ton armored truck that has the payload of a Humvee (High Mobility Multi-purpose Wheeled Vehicle) and yet is svelte enough to deploy from a tactical aircraft [see photo, "Shadow"].

General Dynamics Land Systems in Sterling Heights, Mich., a subsidiary of General Dynamics Corp. in Falls Church, Va., is the defense contractor that designed and assembled the RST-V. The company estimates that the vehicle would consume just 200 kilograms of fuel during a month-long reconnaissance deployment, about 270 kg less than a Humvee would. It accelerates twice as fast, zipping from zero to about 97 kilometers per hour in 12 seconds. And the RST-V can travel 32 km on battery power alone, moving almost silently. "You just won't hear this thing coming," says Jeff Bradel, manager of maneuver science and technology for the Marine Corps, who led the military's RST-V technical team.

The RST-V is the product of a US $30 million Marine Corps research program initiated by the Office of Naval Research in 1997 and cofunded by the U.S. Defense Advanced Research Projects Agency (DARPA). The Marines wanted a vehicle that would fit inside the V-22 Osprey tilt-rotor aircraft, the controversial vertical-takeoff airplane that the Marines hope to begin using in 2007. In 1999 the Office of Naval Research and DARPA selected the General Dynamics design and ordered four identical demonstration vehicles.

Like the Army hybrid Humvee, the

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RST-V is a series hybrid. A 2.5-liter diesel engine cranks a 110-kilowatt generator, which feeds electricity to a 20-kilowatthour lithium ion battery pack and to four 50-kw motors, one at each wheel.

What distinguishes the RST-V from its predecessors is the design and placement of its motors, which are squeezed inside the hub of each wheel. The brushless motors are built by Magnet Motor GmbH in Starnberg, Germany, and rely on powerful rare-earth permanent magnets developed in the 1990s to induce a magnetic field in the rotor; power electronics commutate the current in the stator coils.

The first hybrid Humvee demonstrated by DARPA in 1990 also ran on brushless dc motors, made in that case by UQM Technologies Inc., in Frederick, Colo. But those motors were attached to each wheel's drive shaft. By squeezing the motors into the hub, the RST-V eliminates the drive shafts, greatly improving traction. Whereas the Humvee's mechanical drive joints limit the vertical travel of its wheel to 25 centimeters, only power cables and a flexible coolant hose link the RST-V's wheels to its axles, allowing them 45 cm of vertical travel. That keeps the tire treads engaged with rough ground more of the time. "We couldn't do that with a mechanical system," says Bradel.

Still more important, in-wheel motors enabled RST-V's designers to bypass a potential showstopper: rollover risk. To fit in the V-22's cargo hold, the RST-V's chassis was constrained to just 150 cm side to side. That's 10 cm narrower than the Jeep, whose tendency to roll over was a prime consideration in the design of its relatively beefy replacement, the 215-cm—wide Humvee.

The RST-V achieves stability during operation by extending its wheels sideways 20 cm beyond the chassis, achieving a total wheelbase of 190 cm. "It's just like a Transformer," says Bradel, referring to the toys that convert from one thing into another. The key is a folding pneumatic suspension, something that's all but impossible with a mechanically driven wheel. Bill van Amburg, a hybrid-truck expert at WestStart-Calstart, in Pasadena, Calif., cites the RST-V as proof that you can "design a vehicle very differently when you design the hybrid drive in right from the beginning."

When will hybrids hit the battlefield? General Dynamics plans to enter the RST-V in the competition for the Marine Corps' next major procurement program: a "light strike" vehicle to fit into the V-22. Tom Trzaska, manager of developmental programs at a General Dynamics technical center in Muskegon, Mich., acknowledges that the RST-V bid may not be the cheapest. He pegs the mass-production price at 20 percent more than that of the military Humvee, which costs $65 000—$70 000. But Trzaska says reduced fuel and maintenance costs should compensate.

The question is whether the military is ready to pay more now. The Army was to field several hundred hybrid Humvees by 2007 but has frozen the program. Industry sources say that given the ballooning costs of Iraq operations, the military can't afford both to replace damaged diesel Humvees now—though they consume 26 liters per 100 km (about 9 mpg)—and to invest for the future in better vehicles. Ironically, one of the biggest-ticket items for Operation Freedom has been diesel fuel. **—PETER FAIRLEY**