

## The future of Heavy Armour - Weight watching

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**Recent battlefield experience may speed the development of active protection systems, but in the interim, the solution is inches of armour. Nathan Hodge reports**

**In July 2003, the US Army's V Corps issued an after-action report that noted the decisive role of heavy armour during the push to Baghdad. "The decision to leave an armoured brigade in the centre of Baghdad overnight seemed unthinkable one day and obvious the next," the report said. "We must never underestimate the psychological impact of an American armoured force holding the ground it takes."**

Those 'thunder runs' into the Iraqi capital may have proven the worth of tanks in high-intensity combat, but the conflict in Iraq has since shifted to a complex counter-insurgency fight. The main threat to US armour systems today is the improvised explosive device (IED), which continues to evolve in lethality and sophistication. For insurgents, an Abrams main battle tank (MBT) or Bradley infantry fighting vehicle (IFV) is seen as a 'trophy vehicle' that can be targeted for maximum propaganda effect.

Now that force protection is one of the army's top priorities, the service has spent heavily to boost the survivability of heavy armour systems in close urban combat scenarios. Most recently, the service awarded General Dynamics Land Systems a contract worth USD45 million to deliver Tank Urban Survivability Kits (TUSK) for its M1A1 and M1A2-series MBTs. The TUSK system includes remote thermal weapon sights, external gun shields, a tank/infantry phone, explosive reactive armour (ERA) tiles and rear slat armour.

According to the army, existing survivability measures - such as ERA on the Abrams and Bradley and slat armour on the Stryker wheeled combat vehicle - have provided good protection against a cheap and ubiquitous anti-tank weapon: the rocket-propelled grenade (RPG). Of 63 soldier fatalities the army attributes to RPG attacks in Iraq, only 10 were the result of RPG attacks on armoured systems such as an Abrams or Bradley.

For army planners, however, future armour developments hinge on a new definition of survivability.

In a recent presentation to an industry audience, Lieutenant General Joseph Yakovac, military deputy to the Assistant Secretary of the Army for acquisition, logistics and technology, said: "Historically, survivability has been defined by inherent armour - inches of something," he said. "That's no longer acceptable. Today ... I can design something that will punch a hole in anything."

According to Gen Yakovac, the army now views survivability in an altogether different way. Instead of relying on armour, which is increasingly vulnerable, the service wants information - seeing the enemy first - to provide the outer layer of self-protection.

That vision is supposed to be realised through a family of manned ground vehicles being developed under the rubric of the service's Future Combat Systems (FCS) programme: an ambitious modernisation effort led by systems integration team Boeing and Science Applications International Corporation (SAIC). The FCS 'hit avoidance' team, led by BAE Systems, has tasked Raytheon with development and integration of an active protection

system (APS) that will be able to shoot down incoming anti-tank rounds. The APS is planned for both FCS manned ground vehicles and legacy vehicles as part of technology 'spin outs'.

In the interim, however, the basic threats remain.

Since 2003, the army has absorbed hard lessons from combating IEDs while accumulating significant new experience, particularly with its Stryker-based interim armoured brigades. Army leadership has promoted Stryker Brigade Combat Team (SBCT) deployments as particularly successful; most recently, theatre commanders shifted the 172nd SBCT to Baghdad to shore up security operations in the capital.

The ever-shifting IED threat also underscored the vulnerability of light tactical vehicles such as the Humvee. At the beginning of the war in Iraq, US Central Command had a requirement for 235 up-armoured Humvees, mostly for military police units. The in-theatre requirement for up-armoured Humvees today is 18,669 vehicles; production has increased to more than 1,074 up-armoured Humvees per month from about 30 per month at the beginning of the war.

Nearly all of the army's Humvee production is now armoured and companies such as Armor Holdings have secured major orders for armour components for the vehicles. Armor Holdings has also developed armoured cabs for the army's main logistics platform: the Family of Medium Tactical Vehicles (FMTVs). Iraq has also marked the return of the armoured car, with the army placing sizeable orders for the 4 x 4 Textron M117 Armored Security Vehicle, now seen as an essential tool for convoy security.

Humvees, however, were never meant to be armoured troop carriers. The US Army and US Marine Corps are now studying a possible replacement for the Humvee - the Joint Light Tactical Vehicle - that is built with a baseline armour kit. If the programme moves forward, it would mean buying a large fleet of lightly armoured vehicles.

### **Active measures**

The recent Israeli experience in Lebanon has also prompted new examination of survivability. As reported in *Jane's*, anti-tank threats posed serious challenges to the Israel Defence Force (IDF) during the Lebanon offensive: a total of 20 IDF Merkava Mk 2, 3 and 4 MBTs were lost in Lebanon; 14 of those tanks were lost to anti-tank guided missiles (ATGMs). Nearly half of the Israeli MBTs hit by Hizbullah ATGMs were penetrated, according to a post-action analysis.

The vulnerability of MBTs in Lebanon prompted the Israeli Ministry of Defence (MoD) to accelerate its investment in APS. *Jane's* recently reported that the Israeli MoD has asked Rafael Armament Development Authority to speed development of its Trophy APS, now scheduled for delivery in 2007. The IDF is also planning the future evaluation of another system, Israeli Military Industries' Iron Fist APS, for possible procurement.

APS is already a planned part of FCS. Earlier in 2006, Raytheon received a contract worth up to USD70 million from BAE Systems - the FCS 'hit avoidance' integrator - to develop the hard-kill system for FCS manned vehicles under a three-phase agreement. The initial phase is valued at USD10 million.

Army leadership says APS has already seen rapid progress since the contract award to Raytheon. Major General Charles Cartwright, the army's FCS programme manager, told *Jane's* that the system was already shooting down live warheads in testing. Also, he said the service was already exploring ways to incorporate active protection into its tactics, techniques and procedures (TTPs).

"Yes, [I'm dealing with] live rounds; yes, I'm in testing; and yes, soldiers are involved in

working on TTPs for collateral damage," he said, "and this is a true 360o system."

Gen Cartwright and others in the army have stressed that the Raytheon-developed APS will provide overhead cover - for example, against top-attack ATGM rounds - as well as side attack from RPGs. What distinguishes the Raytheon-developed APS from other systems, Gen Cartwright said, is a vertical launch system that will allow interceptors to be stacked and packaged in an efficient way on any vehicle (versus horizontal systems, which must be mounted on points around the vehicle). Many of the details from testing the Raytheon APS are still classified, but the service says it is on a path to deliver a capability for limited user testing around 2010.

In recent months, however, the army has come under pressure from lawmakers to look at the Trophy system, which Rafael has marketed in the US together with General Dynamics.

Earlier in 2006, a Stryker equipped with Trophy underwent validation testing in support of the Full-Spectrum Effects Platform, also known as 'Project Sheriff': an initiative to install a range of lethal and non-lethal technologies on a vehicle for crowd control and urban operations.

Trophy's designers have marketed the system as approaching maturity; according to Rafael representatives, the only reason the system was not incorporated onto IDF vehicles before the Lebanon operation was because of budgetary constraints.

The army, however, has taken a much more sceptical view, both of Trophy's technological maturity and its readiness for integration.

"We will continue to monitor what they [the Israelis] do and see what happens, but there are some additional assessments that will have to be done," said Major General Jeffrey Sorenson, deputy for acquisition and systems management to the Assistant Secretary of the Army for acquisition, logistics and technology.

The army has also approached the adoption of active protection with some caution. One of the concerns, Gen Sorenson said, is collateral damage to dismounted soldiers or civilians.

"We are [operating] in very tight urban areas," he said. "Yes, we can take out an RPG, but if you watch and observe how the soldiers function there in the urban environment, these vehicles are coming down the street and soldiers are walking alongside them - as are non-combatants. So while we might be able to take out that RPG, we'd probably kill 20 people in the process."

The backers of Trophy dispute that account, saying the system was especially designed to minimise collateral damage. It uses an inert warhead to strike the incoming target, meaning in many cases that the threat warhead will disintegrate instead of detonating. The Raytheon APS for FCS uses a blast fragmentation warhead, but its vertical launch design is supposed to reduce potential for collateral damage by limiting the fragmentation cloud from a successful kill.

The performance of APS is integral to the success of the FCS programme: that defensive capability will allow the FCS manned ground vehicles (MGVs) to trade size and weight.

In the army's concept, MGVs are supposed to be sized for urban combat - and more deployable than the behemoth Abrams or Bradley.

MGV variants will include an infantry combat vehicle with a crew of two and nine infantry soldiers; a mounted combat system with a 120 mm direct-fire weapon; a 155 mm non-line-of-sight (NLOS) cannon; and an NLOS mortar (NLOS-M). FCS manned systems will include a command and control vehicle (C2V), a reconnaissance and surveillance vehicle (RSV), a medical and evacuation vehicle (MedEvac) and maintenance and recovery

vehicle (MRV).

BAE Systems is the lead for developing NLOS-C, NLOS-M, MRV, MedEvac and ICV vehicles; General Dynamics is working on the C2V, the RSV and MCS.

A key performance parameter for the FCS manned systems is transportability. The MGVs were originally sized to be transportable on a C-130 Hercules tactical airlifter. However, as the army and the systems integration team looked at the design weight, they decided that the MGV family would be 'optimised' for transporting three systems on a C-17 Globemaster III heavy cargo aircraft.

The C-130 option, however, has not been completely ruled out. In a recent FCS briefing, Gen Sorenson said: "We are not designing it to fly on this [C-130] craft, but we are not designing it to prohibit it on this craft."

### **New wheels**

Another subject for study within the armour community is the army's experience with the eight-wheeled Stryker vehicle. The 3rd SBCT, 2nd Infantry Division, first deployed to Iraq in October 2003, and the unit recently returned for its second rotation to Iraq; it replaced the 172nd SBCT, which moved to Baghdad to bolster security in the capital.

Stryker medium armoured vehicles have been praised by commanders for their performance in urban combat, particularly for their 'run-quiet' characteristics.

In a recent presentation, Lieutenant General David Melcher, Deputy Chief of Staff for Programmes, said Stryker vehicles "have really acquitted themselves well" in Iraq.

"The insurgents don't really like this vehicle because they're so quiet and you can't hear them coming - which is one advantage we didn't think of," he continued.

US special operations forces have also taken on interest in the Stryker. A 2005 army news item noted that 75th Ranger Regiment would also have Strykers at its disposal in future deployments. Although US Special Operations Command (SOCOM) would not comment on equipping special operations units with the vehicle, the news item quoted General Bryan Brown, commanding general of SOCOM, as saying the special operations community was "excited about using some of the army's Strykers".

The baseline Stryker, however, is relatively lightly armoured. For deployment in Iraq, the army added slat armour - essentially a steel "bird cage" around the vehicle to pre-detonate RPGs and other shaped-charge weapons before they strike the vehicle's armour.

As ungainly as it looks, slat armour has been credited with saving lives. However, it is an interim solution. In his recent briefing on active protection issues, Gen Sorenson suggested that explosive reactive armour is part of the army's plan for Stryker as well.

At present, however, the main issue for the US military to contend with is facing the IED threat and, in combination with other technology such as aerial surveillance and radio-frequency jammers, the solution has primarily been to 'heavy up' US and coalition vehicles.

The story of the Textron Marine and Land M117 Armored Security Vehicle (ASV) is illustrative. At the beginning of the war, the ASV was a rather obscure piece of kit in the army inventory. The vehicle was developed largely for use by military police units and the army had no further plans to buy additional vehicles.

War in Iraq changed that.

The ASV features a fully enclosed turret as well as a blast-protected V-shaped hull, and it was seen as an excellent vehicle for convoy security operations. The Iraqi government also received a quantity of 'stretched' ASVs for ferrying officials along dangerous roads.

The US military also began a dramatic investment in mine-hardened vehicles, using emergency funds to buy vehicles like the Force Protection Cougar and the BAE Systems RG-31: designs built with a V-shaped hull to deflect blast from occupants.

That overlaps with a trend toward armouring utility vehicles. As a consequence of the roadside bomb threat, the US military has increased the armour protection on the Humvee, buying both up-armoured versions and bolt-on armour kits. However, the addition of armour and ballistic glass means a major increase in weight, putting serious wear and tear on the vehicles in the inventory.

Recent improvements to the Humvee have included a more powerful drive train and transmission. The vehicle, however, was not originally designed to be hardened, and the flat-bottomed design tends to act as a 'blast trap'.

The US Office of Naval Research (ONR) recently selected General Dynamics Land Systems and Oshkosh Truck to build concept designs for the JLTV. The ONR has budgeted up to USD2.5 million to buy up to five mock-ups for the JLTV design study. As Jane's went to press, no additional contract had been awarded.

The JLTV may come in different configurations: combat tactical, command and control and utility variants, a light infantry squad carrier and a reconnaissance vehicle. It will have a basic ('A kit') armour package as well as a bolt-on ('B-kit') addition.

Up-armouring soft-skinned vehicles also means outfitting large trucks with armour. Stewart & Stevenson, an Armor Holdings company that makes the army's FMTVs, has developed an armoured cab design for army trucks; DRS Technical Services makes an applique kit.

Israel's Plasan Sasa (as a subcontractor to Armor Holdings) developed a protection kit for the USMC Medium Tactical Vehicle Replacement (MTVR): a logistics platform made by Oshkosh Truck.

John Stoddart, Oshkosh's Executive Vice President and President, Defence, said planners need to look at the "entire package" when it comes to developing an armour protection strategy. Survivability, he said, can mean everything from mitigating the impact of a blast - incorporating V-shaped hull designs, special seats to absorb force or even airbags - to adding inches of armour. "The best way is to develop an armour package that cocoons the most important part of the package: the driver and crew," he said.

Further down the road, he added, unmanned systems may obviate the need for some kinds of armour.

"We are working very hard on an unmanned vehicle, which is a very good solution because that aspect of survivability is in some cases better than armouring the vehicle."

[Israeli armour fails to protect MBTs from ATGMs \(jdw.janes.com, 25/08/06\)](http://jdw.janes.com, 25/08/06)

[Israel armour protection system 'revolutionary' \(jdw.janes.com, 11/03/05\)](http://jdw.janes.com, 11/03/05)

[US, Iraqi forces move to shore up Baghdad security \(jdw.janes.com, 11/08/06\)](http://jdw.janes.com, 11/08/06)



An Active Protection System is key to keeping **Future Combat Systems vehicles** light. (Boeing)



The US Army's **Abrams main battle tank** has been upgraded for urban warfare. Like the US Air Force's B-52 bomber, it is expected to remain in service for many more years. (US DoD)



US Army soldiers take cover behind an **up-armoured Humvee** during a gun battle in Salah Ad Din in Iraq in July. (US Army)



The **Bradley infantry fighting vehicle** has been upgraded with explosive reactive armour tiles. (US Army)



The US Army's **Stryker medium armoured vehicle**, seen here with slat armour for RPG protection, has been praised for its effectiveness in urban combat. (US Army)



The US army is upgrading its **truck fleet** with armour. (Plasan Sasa)



The US Army has invested significantly in mine-hardened vehicles like the **RG-31 Nyala**, seen here following a mine strike. (USMC)