Lightening the Weapon Load

Cranfield have found significant weight savings is the small arms fielded by the UK in Afghanistan with clear applications to other designs

The task given to Cranfield University, formerly known as the Royal College of Military Science under the UK's Reducing the Burden on the Dismounted Soldier work was to reduce the weight of the weapon which has stayed stubbornly resistant to weight savings while in contrast, significant weight savings in Electronic Counter Measure equipment have already been found.

Specifically the task was the reduction of the weight of the weapon systems or weapon systems and ammunition carried by fire teams by 50 percent without a loss of effectiveness.

"That is a fairly difficult vision. If you make a weapon light, sadly it has terrible recoil characteristics and you can't hit a thing with it," commented Stuart Dowling, part of the programme.

A very short programme, work started in December 2009 and by January 11 demonstrations were completed using prototypes with the final report submitted in March 2011.

"[We] invited the Infantry Trials and Development Unit (ITDU) to put some common sense into the equation by having people who actually used the equipment involved. We also had an Industry day to invite them to say what they considered to be the possibilities."

Techniques and solutions

One of the approaches being addressed was the use of Stellite in the barrels. Dowling said, "With a rapid firing barrel, eventually the barrel temperature will rise and will burn out the barrel which means you need to carry a spare barrel. Stellite is an unusual material. It is extremely hard and it is normally carried in two places; in the valves of large engines or in prosthetic hip joints. The barrels were lined with Stellite to see if we could ignore the temperature rise and not burn the barrel up. Once we did that we could then decide if we could do two things, just use the barrel more and not carry a spare or could we allow the barrel to have material taken off it. We tested it and did temperature profiles on it and the result was we were able to say yes, theoretically we could use the barrel for lots more rounds and not swap it or we could we could remove material to save weight."

The team also looked at weight savings in the areas of Picatinny rail, slide rods, upper receiver assembly and the trigger mechanism housing.

Dowling said, "The SA80 was designed for one purpose and used for many more. We had to keep the existing working mechanism. There was no budget and no time to say that the gun was too heavy, why not just get another one. We had to stick with it. We had to look at alternative components if you like and what we did was to use Computer Aided Design and we then used Finite Element Analysis to ask where the stress was in the mechanism to determine whether we need strength there or not. If we don't need the strength, can we then lighten the components to save weight so we can then eventually get to our mission of saving weight? We used an awful lot of rapid prototyping."

Using this process and working in conjunction with partners Frazer Nash, parts of the gun's furniture were replaced with rapid prototype plastic components without replacing any weapon critical safety parts. Dowling said, "What we achieved was weight saving without a completely new weapon programme with all the expenses that would incur. We looked at the upper receiver as well as the Picatinny rail assembly as well as the Trigger mechanism housing. The two recoil rods on this gun are steel. Our plan was if we could replace them with titanium that should be able to save some weight there and that is exactly what we did so we looked to replace component in that way."

The two recoil rods were replaced with titanium with a 90g saving per rod. It was tested in multiple firings without problems. Instead of the rapid prototyping plastic, a more robust carbon fibre was used for the upper receiver and the trigger assembly.

Addressing the underslung grenade launcher, the furniture was adopted to fit the weapon in a lightweight housing. The operating mechanism of the UGL remains unchanged but overall there was a 30 percent weight saving, representing a 430g reduction.

The first of two prototype weapons were completed in January 2011 with firing at the end of that month which found magazine slippage with some wear of the case leading to modifications. The ITDU undertook the firing of the weapon at Warminster in early February which required prior Defence Ordnance Safety Group approval.

The programme also looked at off the shelf solutions including the US Lightweight Small Arms Technologies (LSAT) programme and its ammunition, other lightweight bullet casing and plastic ammunition links. Cranfield brought the LSAT weapon to the UK and fired it in March 2011. The Cased Telescopic Ammunition used was 40 percent lighter including links while the Light Machine Gun was 45 percent lighter than the M249.

Cranfield looked at General Dynamics OTS sourced corrosion resistant steel round which are lighter than conventional brass rounds by 30 percent which saves 4g per round at 7.62mm and 2g at 5.56mm. Dowling noted that for this approach to be successful, the new metal must survive ten years of storage

Plastic rather than steel links of two different designs were used, one created by Cranfield for the work a tessellated design with ridges and grooves to improve its rigidity and strength and the lesson but were found to stick.

The links were tested under various conditions including Mud, Frozen, Heated and other chemical attack tests

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► with no stoppages identified in 500 rounds fired although some links broke on exit from GPMG. The actual weight savings were 2.25g per link at 7.62mm or 457g in 200 rounds or approximately 5kg in 2000 rounds but the plastic used was considered to be too brittle, probably due to its high glass content. Dowling notes that the aerospace industry have has to deal with using plastics in an extreme temperature and high shock environment

Cranfield's work on a radar fuzed Radar 40mm grenades addressed the weight issue by being more effective per round and thus fewer rounds would need to be carried to create the same effect. The effort focused on a very cheap proximity fuze using a 24Ghz doppler radar module which is extremely cheap, roughly eight Euros. This prototype included a circuit board to do the processing of the signal creating a relatively cheap fuze and doesn't require a fire control system. Cranfield is in discussion with Rheinmetall on how to take the design further.

Amplifier and filtering systems were prototyped and bench tested with testing including a complete system in a grenade housing using an inert grenade, side/drop tests to examine fuze sensing from a 10 metre gantry and firing into soft recovery bed followed by function tests. It has never been tested with an explosive payload for obvious reasons. ■

SA80 WEIGHTS WITH PLANNED DESIGN FEATURES AND MATERIALS *CARBON NYLON AND SLIDE RODS*			
Theatre entry SA80A2 no sights/downgrip	4038g	3577g	SA80 P1 (with Picatinny front end and rail)
Theatre Entry SA80 A2 (with Picatinny rail, downgrip, ELCAN)	5290g	4829g	SA80 P1 (with +ELCAN, Down Grip, Aluminium Pic Rail)
SA80A2 theatre entry plus UGL AG36 no sights	5501g	4629g	SA80 P1A with UGL, no sights

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