Weight and Power

Marcus Bruton, Head of the Individual Capability Group at DE&S, discusses two key issues facing British Forces in Afghanistan and other theatres today

"The soldier system is incredibly complex," commented Marcus Bruton, Head of the Individual Capability Group at DE&S. "To come up with a way of thinking about this in systems terms and building on top of it is very taxing. The soldier system is a 35 man platoon. That is what I think of as a soldier system."

The UK's Soldier System architecture is being put in place to improve effectiveness in a coherent and integrated process in order to manage the soldier's burden, mass and power, understanding the interaction between each soldier's individual equipment and controlling the evolution of the soldier system over time.

Power

"Depending on the 36 hour patrol, you will end up with a 12.25kg weight per man solely in power. This is unsustainable but that is where we are," In that eight man patrol there are as many as ten different batteries around the system. These include Lithium-Ion Power System (LIPS 5) for Electronic Counter Measures, the Bowman 354 VHF battery, Bowman 325 HF battery, AA and AAA batteries. He continued, "[They all come] with different connectors, all with different voltages, different cables, different charging systems and in some instances the same battery has several different charging systems. Just to make things more interesting."

Bruton attributes this as a symptom of stove piping capabilities. Control of the Soldier System is being placed into the hands of the Integrated Soldier System Executive (ISSE) which will deliver a holistic response to all aspects of the soldier system.

"What we concluded is that we can't leap ahead and scrap everything we have got. We have too much investment in legacy systems but we do need to do something urgently. We need to treat power as a service and not part of the individual subsystems. In order to achieve this we need a number of purchases in order to deliver this approach." A big bang approach is not being pursued.

Phase 1 of this work is where the UK is at the moment, urgently addressing the burden to meet immediate theatre needs. Bruton said, "The objective was to remove as much as possible by shaving weight off and looking at new ways of doing things that we can deliver now and put into service. It was a fairly low hurdle to deliver which was 20kg but it was quite ambitious."

A major vehicle to deliver the weight savings was Urgent Operational Requirement 1475 which was approved in 2010 and focused on better management of power carriage. The first steps were the August 2010 delivery of 2000 compact LIPS 11 and LIPS 12 ECM batteries. Other elements include Solar Panels, Quad Bike charging kit and a Soldier Portable Charger (SPC) sourced from ABSL.

Bruton said, "What we came up with was to look at a number of things but centred around the Soldier Portable Charger that was developed by ABSL. We looked at a number of charging mechanisms. One of them was LIPS batteries at two thirds and a third size so that guys on the ground only need to take out what they need to take out. They said they sometimes needed half that weight, therefore we came up with number of smaller batteries enabling them to tailor it themselves. We have also developed a quad bike charger kit which allows the guys to scavenge power on the move."

The original quantities of solar panels and SPCs were moved from 75 to 645 at the programme's 'purple gate' in April 2011, based on the unprecedented response to them. The UOR Solar equipment comprises a 63 watt 12 volt foldable solar panel covering one square metre, weighing 1.4kg with a charging time of 2-3hrs depending on the battery type and condition. The UK also ordered 150 Quad Bikes fitted for recharging any battery using SPC with delivery in July 2011.

Phase 2

Bruton describes Phase II, which will span 2011-15 as a much more radical approach, trying to look at other ways of doing things although still looking at the same systems.

The radical approach is needed because of the 13kg removed from the individual DCC soldier's burden in the past two years, only 2kg has come from the power system. Power remains the major area where weight can be removed. Although power scavenging has introduced a degree of flexibility, much more efficiency is needed.

Areas for further work include improving the efficiency of power amplification and antennas on ECM equipment, improved LIPs batteries, methanol fuel cells, a power architecture, standardised connectivity, a man-worn power and data distribution system as well as research into sodium borohydride (SBH) fuel cells.

Bruton notes that adding another fuel type for fuel cells poses its own challenges, "We would have to ship yet another fuel type. We would have to generate methanol somewhere. We would then have to move that logistically from a safe are through to the front line." Bruton notes that the best answer would be a diesel fuel cell.

The Programmes & Technology Group, part of the DE&S is developing a fuel cell using SBH as the fuel. The estimated weight saving could be significant. For a 24hr mission, each man worn ECM set requires 19kg of batteries. This could be delivered using a 3kg SBH fuel cell with five unhydrated cartridges weighing 1.25kg. The potentially saving is 14.75 kg. The greatest savings for fuel cells are on longer duration missions as on short duration missions they can weigh more than the equivalent batteries.

Irrespective of a power source, it has to fit into an architecture and three options are being examined by the MoD currently. The first option is a fully connected power system with a central power supply unit (PSU). While its distribution systems could be used for secondary data transfer and has minimal parasitic mass, new fuel for fuel cells would add to the logistics burden with a single point of failure resulting in additions to the weight because of the consequent the need for a back up. The second option is a fully connected power system with multiple PSUs which addresses the need for redundancy but comes with a significant weight penalty. The third ►

and favoured option is a zonal approach with a power system for example for each of the Head, Torso and Weapon areas which also addresses redundancy but has challenges with parasitic mass.

Bruton commented, "Our analysis at the moment is leading toward Option Three in that whilst Option One does give you minimisation of the parasitic mass, it actually does have the same catastrophic failure if the power supply unit goes down. Option 3 will allow you to lose capability in areas but you then have the ability to allow you focus on what you need at that moment in time. The problem of Option 3 is that you have parasitic mass."

The team has also looked at standardising of connectors and looking at smaller connectors. Bruton cautions that having a single connector is probably not practical as it requires each connector to support the highest power rating of the system which may add unnecessarily to the system. He commented, "That means you then carry more mass than you probably need to. It also then forces you down a bespoke or MOTS equipment reducing the ability to buy COTS. My understanding is that we would probably need two types of connectors with one that is a high power connector."

The team are putting together a concept demonstrator which will look at zonal power supply in the torso using adapter plates and also to come up with a standardised connector or connectors for new equipment and to run that through a series of soldier trials to get to a better design. This will feed into the UK's Virtus protection and load carriage programme and inform requirements over the next couple of years.

Weight reduction of the soldier

"We are now approaching almost unity on weight," explained Bruton. "[Soldiers] are almost carrying themselves. We all recognise that it's unsustainable but we need to do something about it. We have got to this point by filling in capability gaps, what we call the Christmas Tree approach. There has been a lack of integration due to a UOR approach. Body armour hasn't really been something the UK has dealt with but has come to take a major role in the burden to the soldier at 14+ kilos."

Under the Capability Vision, Reducing the Burden on the Dismounted Soldier (RBDS) the scope of the initiative is a reduction from 70kg to a recommended load of no more than 25kg, with additional improvements in ease of carriage, increased agility and decreased probability of heat stress and dehydration whilst enhancing the effectiveness and survivability of the tactical unit and individuals. It has a two year budget of £14m and began in April 2009.

The work on RBDS is divided into four tasks; Lightweight Personal Protection with a target saving of 15-30 percent; Weapons with a target Saving of 5-15 percent and a target saving of 10-30 percent from ammunition, energy efficient ECM and Communications with a goal of 25-50 percent and assisted carriage using a high mobility platform with no target savings *per se* but with prototypes to be delivered within two years with a Experimental Operational Capability from 2011.

That wasn't the end of it as Bruton explained, "We also realised that we needed to come up with a fifth task, which is how we actually sew this together. That is the Soldier System Architecture (SSA)." The SSA's goal is the integration of an open system architecture that allows user experimentation in military environments and scenarios and definition of standards for open systems.

"We have also looked at lightening the personal protection which has grown out of nothing and also looking at saving in weapon systems, One of the other mechanisms we are looking at is how to get the load off the soldier altogether, some of those mechanisms are starting to provide fruit but generally speaking they are only at the edges, shaving stuff off, not really a paradigm shift in order to go from where we were down to where we need to be at 40kg."

"We have managed to reduce the load in number of areas we have looked at battery technology; better power management, use of solar cells, lighter radios polymer magazines. The jury is out on whether that [water scavenging] systems are as good as we think they are. Certainly if you do some significantly difficult testing with high test scenarios it removes 4-6kg from each man."

Every two years, the UK updates what has been fielded and that information is recorded as part of the Soldier Reference Centre (SRC) at Warminster. The last re-baseline was for HERRICK 12 (2010). The generates and hosts a Physical Reference Model which monitors weight and power budget under configuration control, physical protection levels, sustainability models and battlefield missions. It is also an open source for all Soldier System stakeholders from academia, industry and the military.

Bruton outlined its role in soldier modernisation thinking in the UK. "It performs a number of important roles for us; it forms an idea of what is on a soldier system. It also allows us to brief senior management within the MoD on exactly what the soldier system means. It is also part of our configuration control and allows us to actually say that you can't put something on the left shoulder because something is already on the left shoulder."

"Where I want to go in the future is to be able to do this in a virtual sense and actually carry out configuration control in a virtual environment and then to take bio-mechanical simulations so we see what value certain equipment are versus other equipments. This is about balance of investment and balance of tradeoffs."

"One of the things we have got to instigate in soldier systems is the control that is lacking at the moment. One of the ways we can try to do this is to look at how we add things and what the effect of adding that thing to the soldier systems actually ends up bringing and what does that do to add to improve the overall soldier systems effectiveness."

Another area of work is Assisted Load Carriage for which Virtual and Live Experiments have taken place. This gave the vehicles limited autonomy to either be driven manually or with a 'follow-me' capability resulting in an operational weight reduction of 10-12kg per man. It increases the duration of patrol rather than lightening the load and requires a manpower uplift of an extra Junior NCO to control the platforms. The work looked at scaling of three platforms per platoon although one per Squad is seen as probably more appropriate.

Bruton said, "Where we are going is that we are going to develop CONUSE and TTPs before we initiate any future programme. We want to see whether this does anything before I spend time working out a programme." Nine Expressions of Interest were received from Industry with two down-select phases before user trials in September 2011.

Asked whether FIST had changed, Bruton concluded, "We have looked at what we are trying to achieve through FIST. Actually we think that it is better to have the integrator in house. That means from my perspective that we need to make this simple. We need to have this so embedded in the way we think that we are not looking at very complicated systems. You have to have a level of simplicity that allows the MOD to go forward with it. The military also have to understand it in the same way as you don't think about plugging things into a wall. They have too much on their minds in the middle of a firefight to worry whether their systems is going to work when they do X, Y and Z. We need to make it really simple. I don't think we differ greatly from the FIST aspiration. Where we differ in is the delivery of the system." ■

Marcus Bruton was speaking at Soldier Technology 2011.