Situational Awareness - The Digital Dilemma

Operations Analyst and Military Psychologist, ***Dermot Rooney****, who works for MOD and NATO, examines situational awareness and how it can be used in a digital context.*

This place is kinda cute with the map-boards and everything. All our situational awareness is digital now.

US General, visiting HQ 1 (UK) Div, 2003

Situational awareness and digital communications have been developed hand-in-hand over the last twenty years, yet the Army's experience with situational awareness technology has been disappointing. Specialist systems, like those that let Fire Support Teams (FSTs) see videos from Unmanned Air Vehicles (UAVs), seem to have worked well, and systems in formation HQs now perform almost as advertised. The enduring problem has been with *Blueforce* tracking tools that use GPS to allow a vehicle or dismounted commander to *'see where he is and see where his mates are'*.

Even the most evangelical digitizers have grudgingly accepted that the data component of Bowman, the Enhanced Low Latency Situational Awareness system (ELSA) and the Casualty Locating Beacon (CLB) have failed to deliver so far an operational benefit to match their cost in cash, time or effort. The UK is not alone in this. Most of our NATO allies have been stung by expensive situational awareness tools that failed to deliver as promised but, like us, they have been reluctant to admit it.

The cycle of vaunted introduction and veiled discard[1] is depressingly familiar even in civilian technology procurement, but for situational awareness tools there is a digital dilemma that may make it impossible for them to deliver the promised benefits.

The Theory

Typical digital situational awareness tools usually provide four levels of service:

1. *Satnav to show a soldier his current location and let him plot routes;*
2. *Automatic position reporting to show him where other friendly forces are;*
3. *Manually-driven data exchange to let him send and receive text and map markings of useful information like enemy locations and unit boundaries;*
4. *Various 'nice-to-haves' like video streaming, links to cloud databases or smartphone apps that perform functions like calculate water consumption.*

When combined across a battle group these features should give everyone from CO to corporal the same dynamic map display, showing all vehicle and fireteam locations and approximate enemy locations. This clear shared picture of what is going on should allow the unit to realise the elusive tempo benefit of making the right

[1] *Woods et al (1994). Behind human error: cognitive systems, computers and hindsight.*

Pictured is a soldier from First Fusiliers giving commands over the radio and advancing towards the target during Ex SOUTHERN WARRIOR, a Collective Training 2 awarding Rifle Company dismounted exercise facilitated by HQ British Forces South Atlantic Islands (BFSAI). ***Photo: Cpl Si Longworth RLC (Phot) Crown Copyright***

moves faster than the enemy. In theory, this should mean that all tactical activity becomes much more fluid, with the script for a battle group attack looking something like this:

> *During the advance, the shared digital picture means the unit acts much more like a real team, with each element manoeuvring to places that are best for the whole mission, not just their individual circumstance. Because each commander does not have to explain where his subordinate elements are, they can spend less time talking and more time doing. The unit is able to 'march divided, fight united', clearing or bypassing minor resistance using something like sturm tactics but without the uncertainty of wondering whether other sub-units are keeping up.*
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> *When a point man meets an unexpected obstacle, trailing sections can see that the head of their snake has stopped, so they quickly disperse into hasty defences instead of bunching up. Once a way around the obstacle is found, it is sketched onto everyone's map and the advance resumes. When a tank troop assigned to close support gets bogged or hits a mine, another can be switched to the supported company with relative ease. The fuss of reorganisation is minimised because company and troop can see one another and switch voice nets when they get in range.*
>
> *Meanwhile, recce finds that the original Forming Up Place (FUP) is unsuitable, so they*

A soldier with 1st Battalion The Royal Anglian Regiment checks a map location and communicates it on his radio during a patrol in Afghanistan. ***Photo: Corporal Paul Morrison, Crown Copyright***

move it, the associated Line of Departure and the route in. The assault group commanders see these changes and march to these markings without having to stumble about in the dark looking for guides. Direct fire support and reserve groups do the same kind of thing. As everyone has been able to pace their approach the pause in the FUP is minimal, so there is much less lying in the cold waiting for H-hour, or worse, dashing into a rolling FUP to catch up with H-hour.

Now the Gunners come into play. A few well-chosen precision strikes do their thing then they put down a rolling barrage ahead of the assault. But this happens without the all the stop-start that was needed in 1944, with much less chance of fratricide and with no danger of the barrage outpacing the advance.

During the assault, rather than sticking to plans and timings that could be way off the mark or trying to match up different changed plans by voice, the guns can fire in response to tactical events as they occur for the battle group, hitting the enemy as they form up for a counter-attack or sniping depth positions as they are confirmed by reconnaissance. Informed anticipation allows gun and mortar lines to be shifted more often, increasing their security without compromising weight of fire.

In the close combat of the break-in battle, where most people are worried about what

is happening fifty metres away, nobody pays much attention to the digital picture, but those a step back from this can make better use of their time. Direct fire support quickly switches to being the reserve; the old reserve group begins to echelon through to become the new vanguard.

During the reorganisation, casualties are picked up by medics who follow 'on me' map symbols. REME does much the same thing with damaged vehicles, following routes in that have been marked as clear by the people they're helping. Meanwhile, the logistic chain heads straight to the sub-units that have seen the most action, hooking up with their customers in a sensible sequence instead of cabbying about asking everyone where everyone else is.

While they wait to move on, sections and platoons overlap arcs with their flanks using simple shared map tools. But there is less waiting. All these little improvements have stacked up for an 'aggregation of marginal gains'[2] *with a few minutes saved here, a few rounds saved there, and a little less sweat and blood at each point. The overall effect is not a revolution but lots of little evolutions.*

Well, that's the theory, at least... It might be difficult for some readers to credit, but this script more-or-less says what Bowman data was supposed to do, and by doing so help units *'achieve a 60% improvement in collective performance over non-Digitized units'*.[3] MORPHEUS, the Bowman replacement, will probably try to do this too - but it might have trouble. To understand the potential problem for MORPHEUS, it is necessary to rake over the main problem for Bowman.

The Old Reality

Unfortunately, situational awareness is not data on a computer screen but understanding in a soldier's head. In practice, with real kit in the real world, what's on the screen and what's in the head have rarely matched up. There have been many twists of salesman jargon to hide the fact that computers cannot impart real understanding - all they can do is help by providing data that is reliable, useful, usable and secure.

Bowman fell at the first hurdle because it could not pass data reliably enough - and this created a gulf between theory and practice. This gap can be best understood with reference to Exercise BIG PICTURE 1, a trial back in 1997 that found a marked improvement in the performance of a squadron/company group from the QDG and the Coldstream Guards.[4] The results of the trial looked a lot like the theory script above, with vehicles going to the right places at the right time and sub-unit activity synchronised much better than without the digital situational awareness tool. But the trial was conducted in a very crude training simulator where the position reports were reliably and accurately updated every five to ten seconds.

The crudeness of the 1990s simulator, with clunky flat graphics nearer to *Pong* than *Call of Duty*, made it very easy for vehicle crews to get lost, and this exaggerated the value of the satnav feature. Then the reliably frequent position reports meant that a tank commander could look at his screen and be confident that it showed pretty much where every other friendly vehicle was. An icon might lag behind the real position by nearly 300m, but only if the reporting vehicle was moving around 100kph. Most of the time position reports were accurate to within twenty metres - so close that it was hard for vehicle commanders to spot the discrepancy. Unfortunately, by the time this was translated to real kit in the real world, the data was no longer traveling down a fat wire in a simulator shed but being passed over a radio net with a much smaller capacity. Bowman position reports also had to compete with voice transmissions and the unpredictable attenuation caused by range, terrain and weather. Communications capacity proved to be so constrained that once vehicles left the tank park, Bowman would have trouble hitting an update rate of fifteen minutes. The result of this was that any vehicle moving at 100kph could be 25km from where the screen said it was. For day-to-day work, instead of a twenty metre difference, users could only count on an icon being accurate to within a few hundred metres. This was too big a difference for people to trust the data.

The regrettable outcome of this is well known but rarely appears in print. The problem with Bowman data reliability was shown in a series of studies that preceded all the main procurement decisions but

[2] *Dismounted Situational Awareness Concept of Employment (draft, Jan 2015).*

[3] *COS Digitization (2003), Land Digitization Plan, Rooney & Armstrong (2006), Value of Digitization, QinetiQ*

[4] *Morris et al (1997) Ex Big Picture 1 - final report, Centre for Defence Analysis.*

there was a special kind of groupthink hardwired into our procurement system at the time, so we bought it anyway.[5] By my reckoning about two billion pounds was spent on a data system that was never going to do what it said on the tin. The multi-billion pound question now is whether we are bound to make the same mistake again.

The New Breed

Newer situational awareness tools have benefitted from the lessons of those earlier failures. Reliability has been improved by stripping transmissions to the bare bones and applying better data management protocols. Usability (including weight and battery life) has been improved by using proven civilian technology.

Among the best of the current generation is Nett Warrior, the US infantry situational awareness tool. This is based on a commercial smartphone transmitting over a combat net radio and it can send position updates every five seconds with a high chance of successful reception. There is not sufficient capacity to for it to track every soldier and the accuracy is not yet reliable enough for position reports to aid targeting. The benchmark for acceptance trials is that reports show fireteams to within 50m of their actual location, but most of the time this is enough for squad leaders to have confidence in what the screen is showing them. Nett Warrior has sensible manual data sharing too, so soldiers can mark enemy positions and show cleared approach routes. Video communication is not really practical with Nett Warrior but it has some smartphone apps that do handy things.

Improvements to reliability and usability appear to have made usefulness the main constraint on digital situational awareness, and this hinges on the size of the net that can be supported. Vehicle-mounted tools, with more power and larger antennae can cover a whole squadron, though things get tricky with more callsigns than this. As with anything that uses radio waves there are problems in close terrain, particularly in urban areas, but even in open country, the kit the infantry get will only really support a single platoon of eight to ten callsigns (platoon commander, platoon sergeant, and the section and fireteam commanders). Much beyond this and data has to be re-transmitted over company nets, usually with considerable delays, and this limits the ability of platoons to co-operate with one another or with other arms.

So apart from satnav, the core of digital situational awareness is a fairly accurate picture of where the other fireteams in your platoon have got to. It remains to be seen whether these benefits are worth the cost. For digital situational awareness tools to be more useful,

[5] *Rooney (2009), Bowman digitization: a bridge too far, RUSI Defence Systems 12(2) 40-42.*

A U.S. Army Capitan uses the end user device of the Capability Set-13, part of Nett Warrior, at Nangalam Base, Sept 13. The Capitan commands Troop C, 3rd Squadron, 89th Cavalry Regiment. 3rd Squadron is part of 4th Brigade, 10th Mountain Division, based out of Fort Polk, La. (U.S.) ***Army Photo: by Sergeant 1st Class E L Craig, Task Force Patriot PAO), Released***

A British Army Mastiff armoured vehicle on Salisbury Plain during Exercise Wessex Storm. Fitted with Bowman radios and electronic countermeasures and additional armour beyond the standard level they have the best possible protection and situational awareness. ***Photo: Corporal Steve Blake RLC, Crown Copyright***

and therefore clearly cost effective, they need to transmit more data - where the fireteams from other companies are, where an airstrike is going in, or what the enemy is doing. Clever tricks are being tried to achieve this, including rebroadcast over new low-overhead nets, but the solution will ultimately boil down to boosting the power of transmissions.

The Dilemma

The real digital dilemma is that to pass genuinely useful data to enough callsigns, situational awareness tools need to boost the signal. The more we boost the signal the more likely the enemy are to detect it.

This has been the elephant in the room for decades. In the heady days after the collapse of the Soviet Union, security was wished away because encryption would prevent eavesdropping and NATO was only going to be fighting third-rate enemies like the Iraqi Army. As long as we were able to dominate the electronic spectrum, digital situational awareness was set to give us such an edge that it would power a revolution in military affairs. Sadly, that time has passed and the future is set to look surprisingly like the past.

In the 1980s, field training saw whole battle groups manoeuvre for hours with barely a pressel click. This was not done to hide what a unit was saying (encryption was covered by the manual tedium of BATCO) it was done to hide the unit's position. The Russians were known to be very good at radio direction finding (RDF), triangulating and firing tonnes of ordnance at the source of emissions. It would appear that they still are.

In Ukraine the combination of electronic warfare (EW) and multiple launch rocket systems like Grad has smashed battalions. Most open source assessments of Russian EW have focused on jamming because it is fairly obvious when a unit has been jammed. Units spotted by RDF see only a rain of artillery and can never be sure what promoted the bombardment.

Admittedly there is a lot of froth in the news, with Russia *maskirovka* and Western EW marketing departments perhaps exaggerating the threat, but it would be naïve to assume that Russian forces have abandoned their tradition of firing on careless electronic transmissions. It would be especially naïve with the new generation of top-attack weapons, thermobaric explosives and smaller, cheaper EW equipment.

In the 1990s RDF involved truck-sized devices like *Kolchuga* that were designed to track aircraft or locate brigade headquarters. Now RDF comes from manpack devices like Resolve and can easily locate platoons. These exploit the fact that it is far easier to detect a transmission than it is to understand it - so if you need to be within 500m to communicate between fireteams, enemy EW will be able to pick you up 3,000m away. Perhaps more worrying is the development of EW-equipped UAVs like the *Fledermaus*. While situational awareness tools often struggle to reliably pass data a few hundred metres, the less cluttered line of sight to airborne EW allows emissions to be detected at much greater ranges.

Compression, frequency hopping and related tricks can make it difficult to pin down digital position reports but these savings are set to be outweighed by concurrent developments in EW. Smarter computers are able to pinpoint locations from briefer and weaker transmissions, and often using only one sensor. Like all technology it is becoming cheaper and more usable so we will not only have to worry about near-peer enemies, but irregular proxy forces too.

The real gift to enemy EW is the sheer volume of transmissions that come with digital situational

awareness. For a battle group to be digitally self-aware it requires almost two hundred callsigns to be constantly chirping away, broadcasting their position to anyone who has the kit and the wit to listen. Position reports are like dolphin chatter - brief and unintelligible clicks but with so many of them that it would be a simple matter to locate their source. The dilemma seems to present three options: repeal one of the laws of physics (and somehow squeeze a quart into a pint pot); ignore two of the principles of war (security and surprise); or switch off our primary C2 system whenever we fight a competent enemy (train easy, fight hard?). There is a fourth option.

A Solution?

Current situational awareness tools can show a fireteam commander roughly where other fireteams in his platoon are, or show a troop leader where the other tanks in his squadron are, but this level of awareness is not much better than we could expect to achieve from realistic field training. To give a broader picture up to a company group or a battle group will almost certainly require the signal to be boosted further. A deeper picture, such as the US Defence Advanced Research Projects Agency's desire to feed platoon commanders the position, heart rate and ammunition state of every soldier, will have similar emission control implications.

There is a partial solution hidden in the details of the research into digital situational awareness. Automatic position reporting - the source of all those emissions - made geeks like me excited twenty years ago but it might not be the real benefit of situational awareness tools. As with BIG PICTURE 1, where the main benefits now appear to have come from simple satnav and manual data exchange (boundaries etc.), the same can be seen between the lines of trial reports on the whole range of situational awareness tools.

Satnav and manual data transmission do not show a soldier where his mates are, but they do show him where he is, where his boss wants him to go and important things like boundaries and known enemy locations. A situational awareness tool without automatic position reporting would have a much lower power requirement, less weight and, above all, it would be far less attractive to enemy artillery.

Sadly, this simple solution is unlikely to excite the procurement system, because the digital dilemma is a symptom of a more widespread addiction to communication. In the last few decades radio-silent battle groups have been replaced by platoons that can barely travel a few hundred metres without talking about it. This habit will be a gift to any competent opponent.

Back in the 1990s, when digital situational awareness really began, British Telecom ran an advertising campaign with the tagline 'It's good to talk'. The army appears to have been treating this as an unofficial motto ever since. Maybe it is time to reset, to put less faith in what phone salesmen tell us and pay attention to older and less biased advice: 'careless talk costs lives.'

Pictured is the new AJAX prototype shown near its future assembly site in Merthyr Tydfil, Wales. Each AJAX platform variant has extensive capabilities, including acoustic detectors, a laser warning system, a local situational awareness system, an electronic countermeasure system, a route marking system, an advanced electronic architecture and a high performance power pack.
Photo: Richard Watt, Crown Copyright