

Life and Death Decisions using Sparse, Unreliable Evidence (Information challenges and mitigations in frontline military environments)

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Abstract: Junior military commanders must cope with evidence provided in various forms across many bearers from several sources. They need to remember and combine long extracts from briefings, recent radio messages, background contexts and regulations, verbal shouts from nearby soldiers and heavily constrained senses (due to smoke, noise, sheltering in cover, etc) to form awareness of the local situation.

Systems have evolved to share information more clearly and less ambiguously in these environments, and with little extra cognitive load. However, many were developed for regular warfare with well-defined front lines, and current small wars and multinational counter-insurgency operations have made some of these less useful.

This paper describes some of these systems, suggests possibly more useful ways to model them, and outlines issues with ordinary technical solutions. The intent is to describe such an 'extreme' information management/exploitation environment in order to draw out concepts that are hidden in more normal environments, and ideally to spark an interest in readers from other domains who could suggest improvements.

Keywords: Military, People-based, IM/IX

1. Introduction

Information management doesn't get much more interesting than frontline counter insurgency operations. All the ordinary information management and exploitation concepts apply, including mining huge data sets, finding and evaluating small significant items, challenging performance requirements and data fusion issues. On top of that the communications are poor, the information technology is sparse and vulnerable, and the users are usually poorly educated and often emotionally charged.



Figure 1: Clearing a compound, Afghanistan (Jamie Wiseman)

We focus on the front-line operators; the soldiers and junior commanders on the ground and their immediate commanders. These are both the end users and the gatherers of the information, yet usually those with the least sophisticated technology. Manual information systems are therefore relevant, along with the technology layers.

We are not so interested in the higher command because, on current operations, those military headquarters tend to be static and sheltered in an office-like environment, with mains power, desktop computers, local ethernet and good communications with other headquarters. Ordinary information management and exploitation techniques and technologies can be applied.

Existing ways of managing information have been introduced somewhat ad-hoc over many decades and sometimes centuries, and they are not always well understood. Similarly, information technology products have been recently introduced piecemeal and without coordination. It is not always clear what these solve in practice, so we should be wary about making changes that may have unforeseen consequences.

Even gathering information on current information systems and their effectiveness is not easy. Generally, it is difficult to embed researchers within operating patrols to directly study the operating environment. Few good researchers are also good soldiers, and the difference in language and backgrounds can render even direct communication unproductive.

We rely then on discussions with experts (who act as knowledge middlemen), story-based analysis of the end-users' experiences, and observing those training exercises that veterans describe as realistic. The military adapts –in various ways – to changing circumstances, so our understanding of how they manage their information is often out of date and/or contradictory.

We start here with a brief introduction for the non-military reader (which should not be taken as doctrine). We then look at the main 'operating pictures' that are the core of military front-line information management, and how they are distributed. We finally consider ways in which technology has helped, or otherwise, this work.

2. Some Military Basics

A patrol consists of a 'Section' or 'Multiple' 8-12 soldiers, and may be mounted in a group of vehicles, or 'dismounted' when on foot. Patrols are sent out from Forward Operating Bases (FOBs) which are spartan fortified compounds manned by a Company of around 100 men.

Whatever their mission, an important part of any patrol's task is to gather information. The patrol may last a few hours or a few days, and the distance covered can be considerable if, for example, helicopters are used. The patrol is mostly self-contained for its duration; it carries its own food, water, batteries and other supplies. Typical loads, including ammunition and armour, are around 45kg when patrolling (Devil 2003), or 30kg with only the immediate fighting essentials. Individuals have small radio headsets with a range of a hundred meters or so to communicate with each other, and the patrol will have a more powerful radio to reach the FOB.

The FOB acts as a 'node' for supplies and communications. It provides a connection up the command chain, with access to support for the patrol such as artillery, aircraft and engineers, and to detailed information such as maps, images, detailed briefing notes from the 'office' environment of the next command up.

While we will concentrate on the interactions of the patrol members and their immediate commanders, any operation includes interactions with other specialised arms and services. On current operations, soldiers must also cooperate with foreign soldiers, and civilians from other organisations. Note also that the above is only a representative example, sufficient for the purposes of this paper.

Essentially, picture the junior commander on the ground, usually in his early 20s, often poorly formally educated, in command of around ten men, who not only has to make life and death decisions but is also one of the many eyes and ears of the organisation behind him. That organisation in turn must sift through what he sees and hears, combine it with information gathered elsewhere, and pass the resulting assessment back to him to improve his understanding on his next mission.

2.1 Typical Tasks

For peacekeeping to succeed the local population must support it. This requires, amongst other things:

- Continued *effective* presence, to reduce reprisals from the insurgents. This means being able to find insurgents and remove them – arrest, destroy, drive off, persuade – in a manner acceptable to the local population.
- Suitable civilian support, so the military are seen as positive benefits rather than remote and superfluous or, even worse, an aggravation. Understanding the needs of the communities requires engagement; eyes on the ground, discussion, cultural awareness, and continued monitoring of the results.

These require quite a rich understanding of the overall situation that is beyond the stereotyped 'enemy/not enemy' combat engagements. And this understanding has to be gathered and distributed across poor communication links, and stored and analysed and understood with little in the way of computing equipment (See also Hall & McChrystal (2009), Gant (2009))



Figure 2: Assessing a school, Iraq (Trooper M Hill, 2003)

Day to day tasks might include:

- Exploratory patrols: going over the ground, often on foot, making contact with civilians, being available for civilians to make contact (as Fig 2 above), looking over areas.
- Vehicle Check Points: road blocks are erected and vehicles checked for contraband and suspects.
- Strike/Arrest patrols: specific missions to find and arrest particular targets.

There is also the daily grind of personal 'admin' (eating, sleeping, washing) without everyday conveniences, and the maintenance of the group living area and equipment (keeping equipment and living space clean, manning guard points, escorting supply convoys).



Figure 3: Dismounted patrol leaving FOB in foreground (Trooper M Hill, 2003)

2.2 Example scenario

Again, purely to provide background concept rather than describe doctrine, we give an example scenario.

The patrol is driving along in three open topped vehicles. An Improvised Explosive Device (IED) detonates under the lead vehicle, disabling it and throwing the soldiers onto the side of the road. The other vehicles pull up into whatever nearby partial cover can be found, and the soldiers dismount. Bullets are 'cracking' overhead and ricochet from the ground.

All the soldiers are now looking for the ambushers; the wounded will have to wait until they have suppressed the enemy or they may simply create more casualties. Which means there is considerable pressure to locate them quickly; but modern cartridges create very little smoke, the sound of firing is hard to locate in the noise of the passing bullets, and the ambushers are expertly concealed. Examining potential points of cover using telescopic sights loses peripheral vision. Rules of engagement may require clear identification of armed men before the soldiers can open fire, and the enemy know this.

The next actions depend very much on the commander. His own commander at the FOB must be kept informed of the situation, with suitable detail. The wounded must be brought into cover and emergency treatment provided. A place for the casualty evacuation helicopters to land must be found and kept safe. He and his soldiers will try and locate the ambushers, which may take hours and thousands of rounds of ammunition, and then attack, call in indirect fire (such as aircraft bombers) or withdraw. All this time he must ensure that he and his men maintain awareness all around.

3. Tactical Picture

Military organisations use several terms with overlapping and confusing meanings for the relevant tactical information. For the purposes of this paper, we will use the following:

“Tactical Pictures” refer to the tactical information relevant to the tasks and operations in hand. Such information models cannot be perfect or complete, and attempts are mostly directed towards establishing the 'best we can do' rather than even 'good enough'.

“Situation Awareness” (SA) is the understanding that the soldier has of the relevant things that are going on around him, and the intent of his team to change it. This will be informed by what he sees and hears, by reports and instructions, and by reference materials such as pictures and maps.

Junior soldiers are usually occupied with the immediate ground around them; the 'local SA'. It is the commanders who are concerned with the wider picture.

This wider picture includes absolute geo-referenced items such as grid references of points of interest, out-of-date friendly positions, uncertain and out-of-date enemy positions, areas of responsibility and shared reference points. Also relevant are non-geographic items such as the commander's intent, “combat markers” (signs that ambush might be imminent, such as no civilians present when they would be normally), local culture and allegiances, and the condition of his men.

3.1 What's interesting about this picture? Unfamiliar Environments, Background & Context

Generally speaking, when we communicate a situation as quickly and accurately as possible, we need to extract the things that the other person does not know about it, and tell them only that. If it is not clear what the other person knows, this takes longer and less reliable.

We need to use words that distinguish between the background and the items of interest. Apocryphal stories abound of today's soldiers, from mostly urban backgrounds, struggling to describe the location of a target in woodland: “He's beneath that tree!” “Which one?” “That one! That one *there!* The *green* one!”

So it is important to establish a 'normal background' as quickly as possible when deployed to a new area, and to build a shared vocabulary that refers unambiguously to common features.

3.2 Picture-Centric Blue Force / Red Force

The 'traditional' view of Situation Awareness at a command post is a map, marked with locations of friends, enemies, areas of responsibility and various common reference points. Many information tools used by the military – computer based and training and process – are based around these simple friend/enemy concepts (See Figure 4)

These would benefit from ways to show doubt and uncertainty, but anyway have proved largely insufficient for the more subtle and varied information required during counter insurgency. Soldiers and commanders have reverted to ordinary English language to describe the situation to each other.

3.3 Purple Pictures

Counter insurgency and policing operations require a richer picture not least because it is not so clear who is 'friend' and 'enemy', and this changes over time.

Killing suspected insurgents may result in the local picture becoming more 'blue' (friendly) as the indigenous population is released from the terror of what are effectively local armed bandits. Or it may result in it becoming more 'red' (hostile) as relatives of the killed take up the feud, or property or other lives are destroyed in the operation.

We suggest the concept of a 'purple picture' to easily grasp the changing nature of loyalties. It suggests a way of approaching loyalties and how the situation is modified indirectly by activities.

The enemy does not typically consist of a single organisation, and the organisations may vary in their hostility. The "\$10 Taliban" are local youth hired during the agricultural down-time, motivated by a bit of cash, sometimes the fun of it, often intoxicated, usually enthusiastic but very poorly if at all trained. Being local, social pressures affect these latter both as encouragement and discouragement (for more on such social pressures, see Potts and Hayden, 2008). The more dedicated insurgent also comes in several forms; Kilcullen (2009) distinguishes between those who fight to remove the presence of foreign armies or remote political power, and those with global causes to pursue.

All these are relevant to how a local commander approaches local populations, and indeed whether or not to pursue and attempt to destroy the enemy once engaged.

4. Building the Picture

The British Army trains its soldiers together in the formations in which they will deploy. This makes each soldier familiar with the dialects of the people he will work with, and the informal language and jargon that is used to describe the battlespace in that community. Some of that language has grown in that community over many years, and more will be developed during specific training to create terms with common meanings, reducing ambiguity and improving speed of description. It is important therefore that training matches operations to ensure the terms are relevant.

We suggest that a formal battlespace description language (including graphical elements), extending and tying together some of the existing description methods, would improve interoperability between communities, and would further reduce ambiguity and improve the speed of description.

The main form for disseminating information in the army is the briefing. The team is assembled for a

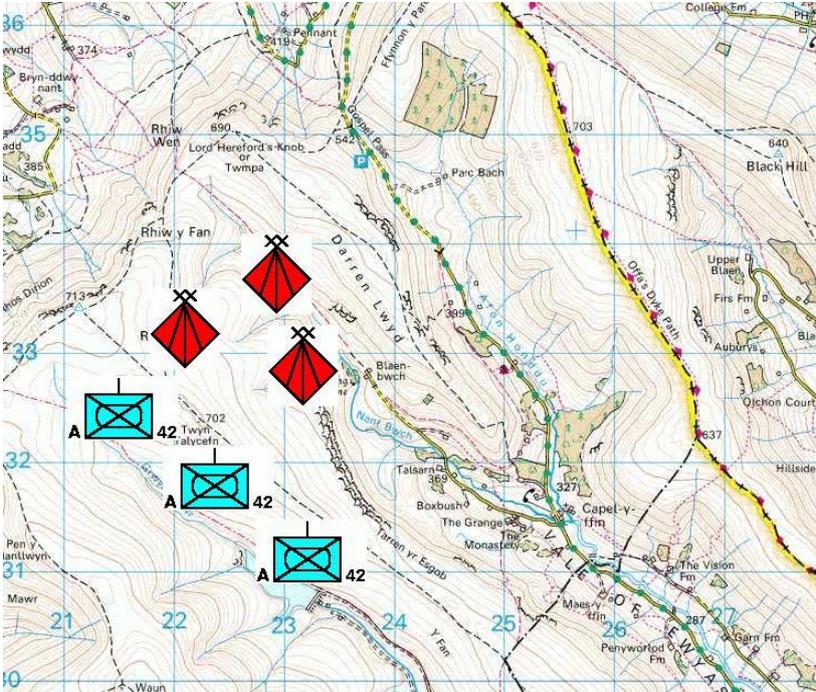


Figure 4: Simple 'Blue Force / Red Force' Picture

single transfer of information, such as background information or orders for a mission. Orders are given in a structured form with standard headings to help direct attention, and mock-ups are encouraged to aid understanding (see Figure 5).



Figure 5: Ground briefing (Major AS Phipps 2003)

Commanders are issued maps which will then be marked up with relevant geo-referenced information such as known friendly units and bases, common reference locations, and areas of responsibility.

Other soldiers are another important source of tactical information; what they have seen, what they have done, what worked and what did not.

On patrol, members communicate by voice, hand signals, and short range radios. The commander can be updated from the FOB using radio, but the limitations – poor quality, intermittent connections, dangers of discovery – mean that rich information cannot be passed this way.

On return the patrol commander writes his report while his memory is fresh but also necessarily when he is fatigued. The report is sent up the command chain to intelligence units to analyse, which is then used to inform future briefings. This separation of intelligence from direct discussion with the commander is not ideal.

The FOB commander has faster radios with more reliable connections, but large information sets such as maps can be put on CD-ROMs and USB sticks and physically transferred.

4.1 Target Indications

Urgent, accurate picture transfer is required when coming under fire; consider our sample patrol above that was ambushed. The enemy must be located and correctly identified to avoid friendly fire or civilian casualties. That information must be accurately passed around the soldiers that are scattered about in various cover with different views on the surrounding area.

The British Army has a set procedure ('drill') for doing this verbally, using structured phrases, key

words, standard angular distances and confirmation procedures. Veterans (ARRSE 2009) and Storr (2009) recognise these have been effective in the far past, but consider that the current training for it is so insufficient, and the resulting marksmanship so poor, that it significantly affects operations.

This drill is a human mechanism for information transfer, and it has proved difficult to provide adequate technology to support it. Acoustic shot detectors can pinpoint the direction and range of a firing point, but relaying this is not straightforward; if the sensor is carried by a soldier lying in an awkward pose, or moving around, then the direction from the sensor rarely matches the soldier's perception. Markers on weapon sights show promise but the technology is still too cumbersome.

4.2 Distributed Pictures

We suggest (Hill 2009, forthcoming) that rather than try to establish a single information model, populated with a 'single picture of the truth' that requires all information to be sent everywhere, we design information systems on the basis that the information is distributed around the organisation as required. This reduces the load on the communication links and the commander's time and attention. Tom Love (1993) makes the general point that monolithic centralised repositories are a bad idea.

Rather than aiming to provide complete information, we should be asking how *little* we can get away with; Simon says "information consumes the attention of its recipients" (Simon 1971).

4.3 Sparsity

Enemy are very hard to find, with few if any cues as to their existence or location. As Biddle says (2004) success in battle relies on nullifying the effect of modern weapons, and much of this is done by hiding. It is sometimes hard for civilians to realise quite how difficult it can be to locate a camouflaged expert who does not want to be seen, and the phrase "The empty battlefield" has long described this. Such information as there is must be separated from the mass of environmental clutter and false targets.

4.4 Trust & Reliability

The British Army's training and ethos promotes units that place considerable trust in the soldiers. (This trust may refer to a confidence in their reliability, rather than in the information they provide. There is often someone in a patrol who can be safely ignored on all things). When dealing with external organisations this trust tails off (McGuinness 2006) even when there is no cause to, and can result in good information being rejected.

When soldiers work with forces from other countries and organisations, the language, jargon and cultural differences can exacerbate communication difficulties. These barriers can be partly overcome using liaison officers; these are people from your organisation that embed with theirs (and vice-versa). Face to face discussion can help to ensure that the meaning of phrases like "It's a bit sticky" are not lost, and the subtle differences between the phrases "This stuff is the dog's bollocks" and "This stuff is bollocks" used by British soldiers is put across.

Communications links can also reduce trust in the information received. Modern radios are generally secure so impersonations are rare. However voice quality can be poor, leading to misunderstandings. Mitigation includes 'voice procedure' training that includes key words to reduce vocabulary, words to aid clarity (such as the phonetic alphabet), procedures to confirm understanding, and certain phrases used in particular situations.

Language, mannerisms and unconscious social signals can be crucial to properly understanding the content of the information being relayed. Face to face meetings can help people to evaluate the source of the information and the content, in ways that are not so easy with a radio or e-mail conversation.

4.5 Correcting the Picture

When new information arrives, it may confirm existing information, contradict it, create a new picture or fill in missing gaps in existing ones. Where the information is contradicted, or assumptions had been made covering the missing information, the picture will need to be corrected. People are not naturally very good at this.

Similarly, the picture can alter in different ways when the same information is received several times. For example, consider the case where three reports are received of a 'technical', which is an armed pickup popular with some insurgents (see Figure 6) but shares some passing similarities to ordinary pickups with scaffolding or other materials in the back. We can produce several different pictures depending on the provenance of those three reports, amongst them:

- Three different observations of three different 'technicals' → considerable threat
- Three different observations of the same technical → confirmation that one exists
- The same observation via three different routes (for example, repeated rumour) → one possible unconfirmed threat
- The same observation in three different reports (radio, verbal, written) → one possible unconfirmed threat.



Figure 6: 'Technical' pickup, Liberia (Wikipedia, unknown source)

The false confirmations in this case – where one observation becomes several apparently different observations of the same thing – is sometimes referred to as 'data incest'. To avoid this, we need to include with the tactical information some more information about where it has come from.

4.6 The enemy is not your friend

When it comes to evaluating all these activities and difficulties in populating the information models,

we must remember that the enemy is working hard to make these problems worse. He will hide to increase the sparseness of your information about him, and do so amongst other people in order to increase clutter. He will attempt to send you false information to distort your information model and perhaps to reduce your trust in other allies, and theirs in you. Any information management systems introduced have to be robust to these attempts.

5. Obstacles to Evaluation

Quite apart from the ordinary obstacles that humans have in evaluating evidence (such as confirmation bias, deferral to authorities rather than information, assuming rather than checking, refusing to modify existing pictures, etc), military operations can provide some unusual ones.

'Cognitive Load' is used to refer to the ability of the commander to absorb new relevant information and make reasonable decisions based on it. Unfamiliar environments tend to swamp the relevant information with clutter and ambiguity. When under fire there are stresses from the immediate emotional response, and more from the pressure to remove the threat quickly. These may both be exacerbated if some of his men are wounded. Exhaustion, immediate physical stress of running with heavy loads, heat stress, dehydration, lack of sleep and so on all reduce the ability of a commander to assess and understand new information. (Many of these debilitating conditions feed-back on each other. Fear may reduce the ability to sleep. Exhausted soldiers may skip eating and so become more quickly exhausted when moving).

So we can expect busy commanders to handle only a few new things at once. Providing them with all the information all the time is not only not useful, it can be harmful. Especially so as the inability to cope with a rich information system will surface more during stressful moments rather than training.

The management mantra is "The right information at the right time to the right people", but it is not clear yet what this means in the military environment; current efforts are mostly trial and error, and there are no good mechanisms (distributed or central) to pass around lessons learned or 'best practice'.

Decision support mechanisms exist. Realistic training provides the commander with the practice to learn what he needs to focus on and what can be deferred or delegated. Repeating procedures until they become automatic (drills) reduces the cognitive load of both manual tasks and collaboration tasks. Rules of Engagement provide guidelines for circumstances that allow opening fire, and can vary depending on the conflict.

6. Automation and Information Technology

Some new technologies have been introduced very successfully and have made dramatic differences to the capabilities of the military. GPS and overhead images provide accurate working ground references to coordinate operations. Modern digital radio systems provide email and instant messaging and file transfers. Modern mobile phones provide every man with a computing platform even without a cellnet link.

Some have not been so popular. Commercial wireless systems could reduce the cables that adorn the modern soldier, but as radio broadcasts they also give away his position, and can be used to detonate IEDs.

The popular saying has it that we "fight the last war". We should also beware of "procuring for the last war" and creating information systems that work only for the current missions. However peacekeeping and counter-insurgency roles are not unusual, and indeed have not been for centuries. Toker (1948) claims that historically linear (conventional) warfare is an exception, so it may be argued that developing systems for current operations will have enduring value.

6.1 Discussion & Social

The rather flippant phrase “All plans fail on contact with the enemy” contrasts with the general doctrine that “Thorough planning is vital to the success of military operations”. It may be that thorough planning is not just about assembling a set of tasks, but about meeting and getting to know your colleagues and their capabilities. Then, as the original plan begins to fail, it is straightforward for the team to collaborate – remotely and with poor communications – to adjust it to the circumstances.

New information technology such as collaboration tools allows people to, for example, work on a common electronic map from remote locations. Social networking software (TIGR) has been 'mashed up' to provide soldiers with familiar peer to peer frameworks for sharing situation awareness. Chat and email provide ways to maintain long discussions.

So the caveat is not that IT tools are harmful, but to take care not to replace existing face-to-face planning where that personal and social familiarisation is important to the resilience of the mission execution.

Similarly, providing automatic gateways between information infrastructures can, in principle, allow different nations to connect up their systems and automatically share data. This provides much more complete pictures, but the caveat here is to ensure that the liaison officer, who would have carried out the language and cultural translations, is not lost without some other mechanism to compensate.

6.2 IT to Head

Information may be to-hand and indeed examined, but it does not necessarily become part of the soldier's situation awareness. A common, long running anecdotal complaint is that radio messages are commonly ignored – even unnoticed – when the commander is busy, despite being broadcast straight into the ear.

More recent examples are the automatic map displays that can be glanced at and assessed with no long term memory being laid down. Car drivers may have noticed that despite driving a new route several times while guided by a satnav, they cannot recall which directions to take at junctions.

This disconnection between human and IT is ignored by some system designs that are satisfied with ensuring that information reaches only as far as the operator's terminal. Extra traffic to acknowledge receipt, and correction protocols to rebroadcast, all add to the communications load and are largely irrelevant; it is the receiver that needs to acknowledge receipt, timely enough for the sender.

6.3 Decision Anti-support

Some information systems encourage dangerous decisions by not providing information when they fail. “Combat ID” is an attempt to electronically label all friendly units, so that remote firers such as attack helicopters can check they are not firing on friendly troops. This is meant to be a safety check to reduce friendly fire fatalities, but it is the wrong one. Equipment that fails, is lost, or is not supplied has no signature, and the enemy has no signature. So a lack of friendly ID merely indicates a lack of friendly ID.

6.4 Augmented Reality

Efforts have been made to provide suitable parts of the tactical information model to the soldier through augmented reality hardware, typically goggles, monacles or weapon sights with displays projected onto the line of sight through them. The technology for doing so reliably, without too much extra weight or power requirements, and without succumbing to the harsh environment, is improving. However some outstanding issues remain: what should be displayed to avoid overloading the view or the mind, what training is required to avoid it becoming a distraction, how can the user interact with it to clear it or switch it, and so on. .

7. Summary

Information management in counter insurgency operations combines all the ordinary information management challenges with a heavily constrained environment where humans are significant sensor and computing components.

Existing systems are in place and being adapted to suit current operations. Further improvements can be made, in three overall areas:

- Understanding the information management & exploitation requirements of counter-insurgency operations
- Systematically monitoring the effectiveness of changes to those systems.
- Distributing the results of that monitoring through the military

We offer this fascinating field as an extreme environment to test the effectiveness of information management techniques and technologies, and invite experts to contribute their work to it.

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