EMERGENCY PLANNING COLLEGE

Emergency Planning College
Occasional Papers
New Series

Number 12
September 2014

Information Management and Shared Situational Awareness:

Ideas, Tools and Good Practice in Multi-Agency Crisis and Emergency Management

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1. Executive Summary

Effective and timely decision-making is critical in emergency and crisis management. To be effective, decision-making requires that the best possible information is gathered, assessed and analysed to provide an understanding of what is happening, why it matters and what might happen. That understanding is the basis for deciding what actions are required to realise the desired end state. Crises and emergencies are however characterised by uncertainty; there might be very little information available or there might be too much to process, what is available might be from a dubious source, information from different sources will often conflict, evidence might be highly technical, fast changing or ambiguous, and the collective effect of this can undermine even confident and highly competent decision makers.

Crisis decision makers working in an organisation of any size do not, or should not, operate in isolation; they should be supported in various ways, and one of the most critical decision support functions is information management. Information management is a tricky business though. While it lends itself to neat and logical flow charts and process diagrams, some of which appear in the following pages, gathering, processing, validating, analysing and communicating information under conditions of inherent uncertainty is extremely challenging. It is then further complicated by the *collective* nature of the business; information management typically involves sourcing and sharing information across internal or external boundaries, and it is at those boundaries that friction, miscommunication, misunderstanding, frustration and breakdowns can occur.

There are two fundamental premises to this paper:

i) information management in a crisis is difficult because of the *inherent uncertainty* surrounding events, their implications and potential outcomes;
ii) organisations and collectives often behave in ways that *further complicate* that inherent difficulty, or at least fail to operate in ways that minimise uncertainty and establish a robust and defensible evidence base for decision making.

This paper describes the factors that create inherent uncertainty in crisis management, and then establishes guiding principles and good practice for organisations and collectives that will enable effective information management. Information management is however a means to an end, supporting the attainment of situational awareness - both individual and shared - across those charged with decision-making and operational activity in the crisis.

The paper sets out to provide a reasonably concise point of reference that establishes the means by which individuals, teams and teams-of-teams develop and sustain shared situational awareness, and what factors can complicate or undermine this, and extract good practice that will enhance the ability of organisations and collectives to manage information to support shared situational awareness in a crisis.

2. Introduction and Scope

Information is generally managed through Information Systems (IS), which comprise Information Technology (IT) and human, organisational structures, processes and ways of working. IS and IT are not synonymous, they are not one and the same thing. Information is managed by people, for requirements that are defined by organisations or partnerships facing often unique circumstances, and subject to standards that are typically defined by relevant authorities. This means that information management is not just a technical activity where all the difficult parts are done by IT. In fact the opposite applies: human thought, judgement and decision-making are the difficult parts and the IT is primarily about physically or digitally linking the people that do this. This is not to diminish the skill of technicians or the critical significance of IT, but rather to make a point about predictability: individuals within teams generally know how each other work, share an understanding of concepts underpinning that work, know what meanings they attach to terms and what expectations they have of each other. While there are potential disadvantages to 'tightness' of team working, for example a potential disposition to groupthink or more overt forms of pressure, we are focusing here on the advantages., and that level of mutual understanding is not automatically the case as you cross boundaries between teams, departments or organisations.

It helps to remember that, because an information system is a human system, little of the information in it can be considered entirely "neutral" or "value-free". Those running the system inevitably place value, meaning and symbolic importance on information as they receive it, select it, interpret it, filter it and disseminate it. Information is, therefore, a socially and culturally significant commodity which will mean different things to different individuals and organisations, according to context. Thus, information that has been through the system is always, to some extent, "framed" by those managing it.

Predictability, in the context described above, is fundamental to interoperability, defined as 'the extent to which organisations can work together coherently as a matter of routine' (JESIP, 2013). High levels of interoperability require ways of working to gather, share and analyse information in a manner that is consistent, and then also *make sense* of the inputs, processes and outputs in a way that is coherent. Making sense of things is the bridge between information management and shared situational awareness and there is a substantial body of work that deals with various dimensions of this, but very little that ties it all together, a gap where this paper aims to contribute.

The paper sets out guiding principles and practical advice that will support efficient and effective teamwork to manage information across boundaries, and enable teams and teams-of-teams to build shared situational awareness. This requires a brief review of some of the relevant academic literature because an understanding of how you as an individual approach evidence and crisis situations is critical to an appreciation of how you can more effectively interact with others to support and make the best possible decisions under difficult circumstances.

3. Context: Multi-Agency Crisis and Emergency Management

This good practice guidance is aimed primarily at decision makers and those who will support them when responding to an emergency or crisis. Both of these terms can be precisely defined and appear in the glossary at Appendix A, but for the purposes of this document they can be defined synonymously as adverse incidents where a scaled-up and sustained response is required, not just by a single organisation, but typically by a range of different organisations, working in a coordinated manner. We acknowledge that this is more characteristic of a public sector, multi-agency response to emergencies where police, fire and ambulance work in concert with local authorities, the Environment Agency and a range of other emergency responders[1] but the principles and good practice set out in this document are largely transferable to other contexts, for example large private sector organisations where different departments, hierarchies or sections may be separated by substantial distance, even time zones, and varying practices and norms.

Crises are generally unexpected, unwelcome, abnormal and novel, volatile, of uncertain character, inherently unpredictable and giving rise to conflict between objectives. The risks associated with making bad decisions can be extremely serious, the level of scrutiny is typically high and invasive, and the evidence base is usually much less complete and reliable than crisis managers would hope for. Specifically, uncertainty of the evidence base arises in large part from the following dimensions of crises:

- ***Suddenness*** – not all crises appear 'out of nowhere', but many are very sudden in onset, and this means that the management of information must be geared up very rapidly and even in slower-onset crises the gradient of activity tends to increase sharply once a tipping-point has been passed.
- ***Novelty*** – crises are almost always novel in some way. This might be because they were entirely unforeseen, because concurrence or intersection with other events resulted in unforeseen dimensions and impacts, or because weak corporate memory has failed to equip the current generation with knowledge of those who have managed such events in the past.
- ***Ambiguity*** – distinguishing between what Silver (2012) has termed 'the signal and the noise' is one dimension of ambiguity, which is the potential for evidence to mean a variety of different things.
- ***Complexity*** – crises often emerge when systems behave in an unforeseen and undesirable manner. These might be engineering, digital, environmental, social or economic systems or (more commonly) a combination of more than one. Because such complex socio-technical systems may not be entirely understood, cascading, interdependent and non-obvious impacts are likely. If failure in such systems is "normal" as Perrow (1999) suggests – as a result of

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[1] *See http://www.legislation.gov.uk/ukpga/2004/36/contents and https://www.gov.uk/preparation-and-planning-for-emergencies-responsibilities-of-responder-agencies-and-others*

their complexity and interdependence – then it follows that such failures are like to produce crises characterised by very complex information challenges.

- ***Volatility*** – crises have a tendency to change, in character, pace, severity and spread of impacts, rapidly and without easily identifiable warning. For decision support arrangements that may be geared to longer timescales, predictable reporting intervals and systems that are generally predictable in cause-and-effect this imposes a whole series of different challenges.
- ***Stressful*** – many of the characteristics of a crisis (e.g. novelty, uncertainty, risk, volatility, scrutiny and high consequence) are inherently stressful for individuals and teams, and it is well documented that stress can have unhelpful consequences for information and crisis management in practice.

In simple terms, the collective effect of these factors is illustrated in *figure 1*. The evidence gap in crisis management arises because the supply of reliable (we cover what this word actually means in a later section) information generally lags some way behind the demand for reliable and actionable information.

> *On the first day of a crisis about 80% of the information you are using will be wrong - you just don't know which 80%*
>
> US Chairman of the Joint Chiefs of Staff Admiral William Crowe, following the misidentification and shooting down of an Iranian airliner by the USS Vincennes in 1988

This evidence gap is, by definition, the zone or period of greatest uncertainty for the crisis manager. It cannot be eliminated, but we suggest that it can be narrowed and its effects reduced. Good information management support can speed up the supply of reliable information to some extent, of course. However, shaping the expectations of crisis managers would also be beneficial, so that they are culturally adjusted to making decisions without all the information they would wish for and so that they become used to, or more comfortable in, situations of great uncertainty.

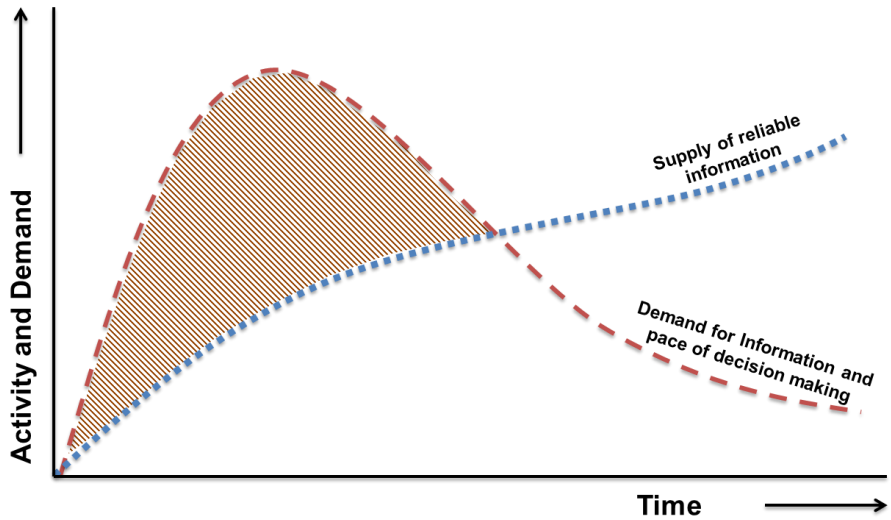


Figure 1: the evidence gap in crisis management

In the following sections we set out a general framework and cover tools and techniques that have the potential to close that gap, noting that the subject of our attention is enhancing the effectiveness, interoperability and situational awareness of those involved in managing the crisis (see *table 1*), rather than tackling the inherent uncertainty of the crisis itself. At times this distinction is blurred, but interoperability is often attained through 'marginal gains', and in a crisis they are worth having.

Inherent Uncertainty In A Crisis	Imposed Or Exacerbated Uncertainty In A Crisis
Casualty figures are unknown because access to the incident site is blocked.	Casualty figures are unknown because relevant data are not shared, triangulated, de-duplicated and verified by different emergency responders.
There may be a single incident, or there may be multiple incidents in close proximity, and until responders have accessed all sites this cannot be verified.	A failure to adopt consistent reporting techniques, for example using the same approach to the geographical referencing of locations.
A hazardous pipeline may have been fractured in an explosion, but no records exist of its precise location.	Risk information known by one organisation is not shared with others.
The outcome of a future ballot on industrial action that may affect the provision of essential services is unknown.	Possible outcome scenarios that are modelled by one organisation are not shared amongst others that would be affected and involved in any response.
The likelihood of a building collapse can only be estimated in general terms, as time does not allow for a full survey.	Terminology in use (e.g. extremely high risk, tolerable risk, probable or possible) is inconsistently used and not commonly understood between emergency responders.

Table 1: general examples to illustrate the distinction between inherent uncertainty in a crisis and that which can be progressively controlled by effective thought, behaviour and interaction between emergency responders

It is important to note that different organisations and professions use terminology differently in this field. For example, the term evidence has a very specific meaning in a policing context, and while it has a much more general meaning across much of the rest of the public sector[2], there is a general acceptance that for information to be evidence it must meet a certain threshold, although the criteria and levels for this are very variable. Similarly the term intelligence, in a military and policing context, refers to information that has been through an agreed process of analysis and has subsequently been graded to a standard agreed by all as to its validity and

[2] For example, the oxforddictionaries.com distinguishes between: the available body of facts or information indicating whether a belief or proposition is true or valid; In law: information drawn from personal testimony, a document, or a material object, used to establish facts in a legal investigation or admissible as testimony in a law court; signs or indications of something.

authenticity. Clarifying what is meant by specific terms when working across boundaries is essential.

4. A General Framework For Crisis Management: Situation, Direction, Action

A wide range of decision models exists, and it is outside the scope of this paper to review them. Most of them however are organised (although the language and layout will differ) around three basic elements; i) what is going on, ii) what are we trying to achieve, and iii) what do we have to do. The general framework set out here elaborates these three basic elements, organised as follows:

- ***SITUATION*** – shared situational awareness: events, their implications and possible outcomes. This forms the evidence base for all that follows, and maintaining that evidence base is a continuous effort.
- ***DIRECTION*** – an explicit statement of what the crisis management effort is working to achieve. A clear end state gives an explicit point of reference for options to be considered, and for the effectiveness and coherence of decisions and actions to be evaluated.
- ***ACTION*** – ultimately actions resolve crises, but they need to be informed and strategically directed, and the effect achieved needs to be captured and fed back as an information flow. Again, this is a constant, rolling effort.

The box below elaborates each of these with a series of questions, answers to which will establish situational awareness, strategic direction and actions to be taken.

SITUATION

- What has happened and what is happening now and what is being done about it?
- So what? What might the implications and wider impacts of this be?
- What might happen in the future?
- What if? What contingencies could arise, and what actions will then apply?

DIRECTION

- Ends: what are we trying to achieve, what is the desired end state?
- Ways: what options are open to us and what constraints apply?
- Means: what capabilities are available to us to realise our objectives?

ACTION

- What do we need to do now?
- What do we need to find out?
- What do we need to communicate?
- What do we need to do next?
- What might we need to do in the future?

Box 1: a general framework for informed and directed crisis decision making

It is vital that they are considered in the right order (taking decisions and actions before determining the desired outcome is, literally, aimless), and that these questions are constantly being reflected on, as the answers will change, possibly very rapidly, in a crisis. Most of the rest of this paper is concerned with situational assessment and situational awareness, but for good practice in crisis leadership and decision making you are referred to BS11200 *Crisis management. Guidance and good practice* (BSI, 2014).

5. Decision Support And Decision Making

> *Tell me what you know, tell me what you don't know, tell me what you think, make clear which is which*
>
> (Colin Powell, former US Chairman of Joint Chiefs of Staff and Secretary of State, on what he expected of his intelligence staff)

At risk of appearing fatuous, the distinction between decision support and decision-making is clear from the words; the former supports the latter. However there is a premise in here, namely that there is a role-separation between decision support and decision-making, and this is not always the case. Recognising that resources are scarce and that staffing levels in the early stages of a crisis might be very limited, it is a principle of good practice that senior and strategic decision makers in an organization should ensure that arrangements are in place for a team to manage information and support the attainment and maintenance of their situational awareness. What this means in practice is elaborated in the following sections.

Commonly experienced quality shortcomings in crisis situation reports:

- Too little information to reliably base decisions on
- Too much information to filter in the time available
- A weak knowledge of context and baseline conditions
- Conflicts between information feeds from different organisations
- Some sources are prioritized because of dependability in previous events
- Some sources are downplayed because they are seen as unreliable
- Overgeneralised reporting that makes it hard to establish their validity
- Ambiguous terminology that could mean a variety of different things
- Timing of supply is out of synch with timing of need
- Format of data or information supply is incompatible with receiving systems
- The crisis relates to conceptually complex systems which are poorly understood
- Technical terminology is used to communicate with non-technical end users
- Classified material may be unjustifiably prioritized over open source material

Box 2: Commonly experienced quality shortcomings in crisis situation reports

Why this matters is illustrated by *box 2*, which summarises some of the challenges and quality issues afflicting information management as the basis for situational awareness in a crisis. Wherever possible crisis decision makers should not be confronted with the friction and detail of problems, although they must be fully aware of the shortcomings of the evidence base and caveats that apply. Attaining the best possible evidence base for decision making in a crisis and creating the conditions for appropriate levels of shared situational awareness is the job of the decision support tier.

There is a tendency, which both authors have seen in practice, for decision-makers to instinctively reach for more and more fine detail when confronted by situations with very complex scientific and technical dimensions that are outside their own professional narrative. *Prima facie*, this might seem laudable – you can't know too much, can you? In practice it encourages decision-makers to step out of role and to "count the trees" rather than "mapping the wood". The strategic overview gets lost in a welter of operational detail, and the extra detail does not help decision-makers refine their understanding or awareness – it merely adds friction and complicates the attainment of SA. At the strategic level, a certain frugality with detail can be a good thing.

6. Information Management – The Basic Framework

Sometimes a pessimist is only an optimist with extra information

(Idries Shah, 1924-1996)

The term information is used here in an overarching sense and in a way that is synonymous with 'evidence'. To be precise data and information are different things. Data are results, observations, counts, measurements, locations, attributes and other basic descriptive characteristics of things and places in a fairly 'raw' format. Information is more processed, ordered, summarised, selective and 'user-friendly' with the intention of assisting correct interpretation. Typically data are high-volume (a lot of records) whereas information is more tightly geared to the requirements of a specific end-use. It is a useful corrective against delay in decision-making (especially early in a crisis when information is in short supply) to remember that more data does not necessarily equal more information. This is shown graphically in *Figure 4* later. The principles and good practice set out in this paper are relevant to both data and information, although the term information (management) will be used throughout.

Information is a critical asset in crisis management, and it should be treated accordingly. The systematic and coherent management of information will establish the best possible evidence base for crisis decision-making (MOD, 2011). *Figure 2* sets out a general framework for managing information, which is essentially a cyclical process of:

- Working out what you need, based on an initial understanding of the problem
- Getting hold of relevant data and information and assessing its fitness for use

- Doing something with that information to answer questions and address unknowns
- Creating and validating outputs which are relevant to the questions / unknowns
- Disseminating and communicating the evidence to end users
- Ensuring that a paper trail of what was done, how, why, with what, etc is maintained
- Closing the loop: ensuring that new information is available for re-use

Figure 2 is essentially a process diagram, and effective and efficient processes are critical in good information management – you simply cannot make it up as you go along. While information management is a relatively 'technical business' (e.g. data formats, assurance and audit), to effectively support shared situational awareness and inform decision-making it must be *meaningful*, and in this regard sound judgement and defensible behaviours are vital.

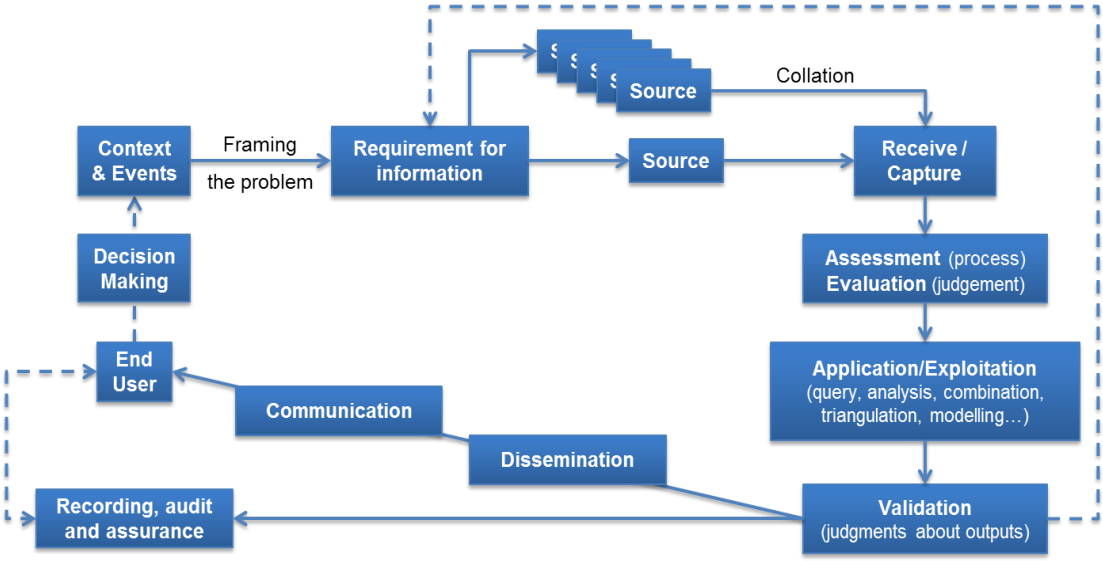


Figure 2: a general framework for managing information

Most organisations will have set out their own framework, principles and good practice for managing information. Where this paper aims to add value to those is exposing some of the difficulties associated with the different links between stages in *figure 2* and the kinds of checks and behaviours that will add rigour and meaning to the activities in those stages. Assessing quality or determining what constitutes reliable information in a crisis is fundamental.

6.1. What Is RELIABLE Information In A Crisis?

There are differing views as to what constitutes high quality data and information, but the three dimensions of relevance, timeliness and accuracy are generally held to be core considerations (*figure 3*). There are two important caveats to this however:

a) You can't have them all, at least not in a hurry! There is an inherent trade-off between getting hold of evidence quickly and getting hold of evidence in which you can have high level of confidence, where high scores on each of relevance, timeliness and accuracy will give you that confidence.
b) There are no universal standards of data and information quality. Quality, and reliability can only be judged in context, and what is acceptable in a crisis is likely to be different to what is acceptable under 'business as usual' conditions.

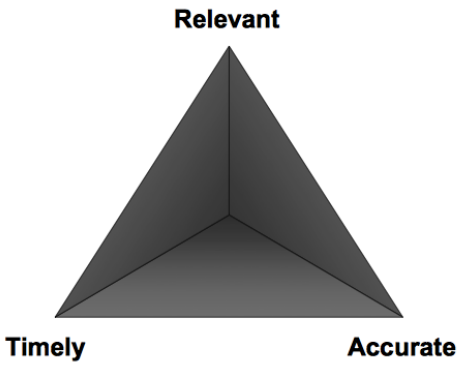


Figure 3: the three core dimensions of information quality

These are not the only dimensions of information quality however and a fuller set of considerations appears in *box 3* (also see DAMA UK, 2013).

a) **Relevance –** the ability of information to meet the real needs of end users
b) **Accuracy –** information that reflects the underlying reality, correctly describing the features or phenomena it was intended to measure or describe
c) **Timeliness** – information that is still current
d) **Completeness** – information that tells the whole story, at an appropriate level of detail
e) **Coherence** – the degree to which the set of information is internally consistent, for example in format, level of detail, metrics and nomenclature
f) **Format** – the accessibility and appropriateness of the manner in which the information is presented to the end user; this includes the ease with which information can be located and accessed, technical format (e.g. version of software used to create it) and mode of presentation (e.g. chart or map against figures or text)
g) **Compatibility** – the ability of a set of information to be combined with other information to add combined value; this also includes both technical format and coherence in the way that both/all sets are structured
h) **Security** – information that is appropriately safeguarded from malicious threats and hazards that may cause loss, damage or compromised integrity and confidence
i) **Validity** – information that is capable of being verified as being of an appropriate level of quality. Validation in itself does not drive up data quality, but it does provide levels of assurance for end users and interested parties
j) **Provenance** – information that comes from trusted sources or through authoritative channels. The definition of what is trusted or authoritative may be based on experiential value-judgment, or might mean that some type of formal grading or assessment has been applied to the information by a competent authority.

Box 3: Dimensions of Information Quality

7. The Concept Of Situational Awareness

Situational Awareness (SA) is a subject that has been studied extensively in the academic literature (the key early reference is Endsley, 1995 and see Endsley and Jones, 2012 for an accessible and current overview), but most of the work on it has had a strong practical focus. Simply put, SA is knowing what is going on around you, combined with the ability to understand the implications and potential outcomes associated with that. A formal definition appears below.

> SITUATIONAL AWARENESS IS the state of individual and/or collective knowledge relating to past and current events, their implications and potential future developments.

The concept and term was initially developed in aviation; as jet planes became faster and faster, work began to consider how pilots' reactions (and proactive thinking and action) could keep up. This work spanned ergonomics (e.g. cockpit layouts), user interfaces (e.g. instrumentation) and crew interaction (what has subsequently developed as Crew Resource Management), but cognitive psychology has made many contributions and led the extension of the concept and practical techniques associated with SA into many different fields.

Endsley (1995) identifies the three basic levels of SA, which have been adopted as central to all subsequent work in the field:

- **Level 1 SA, *Perception***: building a complete picture of what is happening at the event level (which it itself mediated through sensors and reporting media such as command and control systems).
- **Level 2 SA, *Comprehension***: developing an understanding of the events, their causation if relevant and their consequences and potential wider impacts. This draws on existing mental models and fits situations, where appropriate, to those.
- **Level 3 SA, *Projection***: formulating simulations and scenarios of what might happen in the future, and what the implications of those eventualities might be. Mental models are then updated to reflect and accommodate this projected understanding.

This has been simplified, by the Royal College of Physicians and Surgeons of Canada amongst others, to use the acronym GUT:

- **G**et information
- **U**nderstand it
- **T**hink ahead

A wide variety of alternative models have been developed, including John Boyd's celebrated OODA (Observe - Orientate - Decide - Act) loop (Coram, 2002; Osinga, 2007), but this three point core (what, so what and what might?) is common to almost all of them.

Completing the first two levels of SA, but not the third (or not acting on the third) may lead to what crisis managers sometimes call being "behind" the crisis – the unnerving sensation of a crisis moving so fast that one's understanding of it and reaction to it are continuously overtaken by events and rendered obsolete. In terms of the OODA loop it works like this; by the time one has grasped the situation and decided what to do, new events supervene, change the situation and one has to start again. Thus, it is the predictive quality of SA that (potentially) gives crisis managers a basis and appreciation to start exerting at least some sense of control over the crisis.

7.1. Situational Awareness And Mental Models

Endsley (2001, p.3) has written that SA '*can be thought of as an internalized mental model of the current state of the operator's environment'* and this concept of a mental model is helpful in understanding what SA is, and why it can be partial, misdirected or just plain wrong. Mental models are the cognitive representations of the world that we develop and maintain to enable us to describe, explain and predict our surroundings. They are essentially a set of hypotheses, constructed through experience and formal learning, about our environment and situation. They are analogous to other types of models such as maps, 3D physical models or systems diagrams; they are not necessarily complete or free from error, but they enable us to make sense of observations, satisfactorily resolve ambiguities or other forms of uncertainty and project expectations for the future. They allow for this without the need to re-learn or re-reason elements and connections between them.

As we are all different, our mental models differ, so our responses to situations and stimuli are likely to differ as well. Where organisations prioritise training and operate within clearly defined operational parameters and protocols such as Standard Operating Procedures, then the mental models of members of those organisations tend to be quite similar. MacFarlane (2010) relates this to different models of decision making behaviour, noting in particular the association of recognition primed decision making with heuristics and biases (Kahneman, 2012) that impose some limitations on more creative and critical thinking, and may be associated with negative outcomes such as convergence and groupthink (see Appendix C).

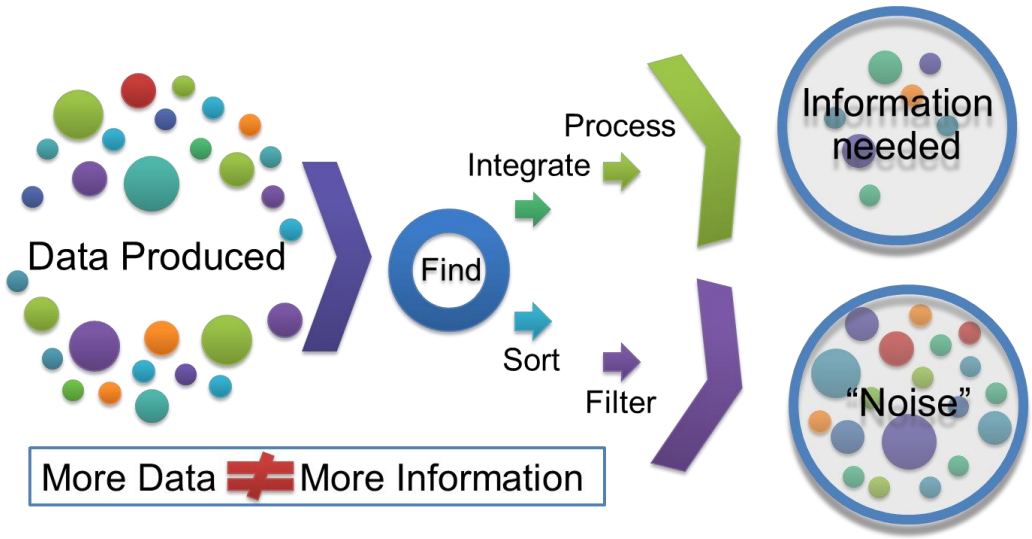
Table 2 illustrates the various factors that can limit, impede or degrade situational awareness and Endsley and Jones (2013) describe a series of 'SA demons' that relate to these factors.

Factors that may limit Level 1 Situational Awareness
• Information is not available (e.g. it was not passed on by a third party or ICT failure) • Information is difficult to detect (e.g. confused signals, distraction, background noise) • Information is not observed (e.g. attentional narrowing in response to stress) • Information is misperceived (e.g. operator sees what they expected to see) • Things are forgotten (e.g. workload overload, distraction or disrupted routine)

Factors that may limit Level 2 Situational Awareness
• No appropriate mental model may be available (e.g. this is a novel situation) • An incorrect mental model may be applied (e.g. respond to what you expect to see) • Inflexibility of thought (e.g. overreliance on assumptions or established procedures)
Factors that may limit Level 3 Situational Awareness
• Lack of experience and appropriate mental models provides no basis for projection

Table 2: factors that can limit or degrade the three levels of situational awareness

Some of these lapses are sub-conscious and correspondingly difficult to guard against, but some of them (e.g. untested assumptions or loss of rigour as a result of workload stress) are manageable through the adoption of structured approaches. This is elaborated in section 14.



Endsley, M.R. and Garland D.J (Eds) (2000)
Situation Awareness Analysis and Measurement, Lawrence Erlbaum Associates

Figure 4: From Data To Information – but how do we do this, inside our heads and 'out in the open' with colleagues and collaborators?

The essence of this is that we as individuals make sense of information in ways that make sense to us. Most of the time this raises no difficulties, especially when faced with previously experienced and tightly bounded tasks within organisations that have clear norms, standardised terminology and quite tightly defined ways of working. Where those conditions are not met (i.e. when we are faced with complex, novel and ambiguous tasks, and have to work across boundaries with conflicting norms and expectations, and interface with different cultures and ways of working) then the scope to achieve and maintain shared situational awareness is substantially complicated (Stern, 2014).

7.2. Intuitive And Deliberative Situational Assessment

The previous section has set out how we, as individuals:

i) perceive signals from multiple sources
ii) comprehend those signals in the context of our experience, knowledge, expectations and mental models, and
iii) project this understanding into an assessment of more or less likely outcomes.

Psychology tells us how we attach appropriate responses to this situational assessment in order that we can respond rapidly as the situation requires it. Psychology also tells us that we do all this in different ways, depending on the circumstances; we are not *either* intuitive or deliberative, but rather we are both, and we are usually very adept at being able to switch between what are termed system one and system two thinking (*table 3*).

System 1 (Intuitive and Associative)	System 2 (Reflective and Deliberate)
Unconscious and automatic	Conscious and controlled
Effortless	Effortful
Associative	Deductive
Rapid and pragmatic	Slow
Parallel	Serial or sequential
Rooted in tacit knowledge	Combines tacit and explicit knowledge
Process opaque	Self-aware
Skilled action	Rule application

Table 3: Characteristics of System 1 and 2 Cognitive Systems
(Evans, 2007; Hodgkinson & Starbuck, 2008; Kahneman & Frederick, 2002)

System one thinking is fast, effortless, implicit and may be guided by emotion or affect. Most everyday activities such as driving a car are governed by our system one cognitive system and they are accordingly highly automatic and cognitively effortless. In contrast system two thinking is slower, conscious and deliberative. It may involve measurement, analysis or formal logic and it is simply is not required for most decisions in life.

So what is intuition? It is essentially a matter of pattern recognition and matching or mis-matching. According to Klein (1999), we look for “cues” in a situation and, based on them, we try to match what we are seeing to our past experiences, and then base a decision on what is appropriate in the light of that past experience. This involves

creating feasible analogies; because a given situation seems similar to a previous one, the observer chooses to understand it and react to it in a similar way. Intuitive decision making can be rapid and highly effective when the individual (or team) has a substantial amount of relevant experience to draw upon. At its most effective, it can give people the ability to sense or feel when something is right or wrong with a situation and what the right course of action is. This is termed Recognition-Primed Decision Making (RPDM) and is most relevant to naturalistic decision environments such as flight decks, control centres in high hazard environments, operating theatres and tactical military operations.

However, intuition also has limitations. Critically, it draws on a relevant experience base. Given that crises are typically novel, complex and possibly ambiguous then matching past experience to perceived events becomes distinctly hit-and-miss. The further one moves away from one's experience base, the more analogies become "stretched" – leading to flawed pattern-matching and false analogy. For further details please see Flin *et al.* (2008) or MacFarlane (2011).

There is also the issue of how to persuade others to accept a choice if it is based on intuition, and the question of how one might defend the intuitive decision if it is challenged after the event – when some form of analysis (e.g. of options and risks) is likely to be expected. Finally, it doesn't avoid the impact of cognitive biases, and we know that observers tend, when considering the validity of an analogy, to instinctively and naturally "play up" the similarities and "play down" the differences. They also tend to focus on salient analogies – the ones they think they learned the most from – even if they are not the most appropriate or applicable ones.

Failure is not an option	***Failure is always an option***
Attributed to Gene Krantz, Flight Director for NASA's Apollo 13 mission (Kranz, 2000)	Sidney Dekker, researcher in complex systems and human error (Dekker, 2011)

Researchers have noted another tendency in analogous reasoning that must be controlled. This is the tendency of managers to identify an analogue from past experience *and then* look for ways of applying it to the current situation or problem. In other words, they start with the analogy and work forwards, instead of starting with the problem and looking back for the suitable analogy. Gavetti, Levinthal and Rivkin (2005) called this effect "solutions in search of problems".

Neustadt and May (1986) suggest ways of improving analogous reasoning. Their recommendation is that the crisis manager should:

- Make (and write down) two lists, of all the likenesses and the differences respectively of the situations that are deemed analogous.
- Then, list (again, by writing down) all that is known, unknown and presumed in each situation.
- Have others critique this appreciation.

The object is to clearly separate that which is known and that which is presumed, and then probe those presumptions very carefully.

> *There are naive questions, tedious questions, ill-phrased questions, questions put after inadequate self-criticism. But… there is no such thing as a dumb question*
>
> Carl Sagan,
> from 'The Demon-Haunted World: Science as a Candle in the Dark'

Intuitive decision making (such as RPDM) is not inherently better than more deliberative, analytic and creative approaches, and deliberative approaches are not inherently better than intuitive ones; they are appropriate in different contexts and in the face of different types of problems. Where situations can be confidently 'typed' and matched to an appropriate response then intuitive approaches will serve experienced people well. When faced with high levels of uncertainty, complex systems in which cause and effect can only be estimated and high levels of ambiguity (the evidence could reasonably support different interpretations) then we suggest a more deliberative approach, rooted in sound information management and making best use of the expertise, knowledge and perspectives available is most appropriate. This is not however to deny the relevance of intuition within a more generally deliberative approach, and for example Klein (2009) advocates the following:

- Do not suppress intuition, but use deliberative analysis to check it – taking care to avoid simply looking for confirmation.
- Conversely, use intuition to check the assumptions underpinning your analysis.
- Use the intuition of "outsiders" or "neutrals" to test the results of your deliberative analysis.
- Confront all doubts in your intuition; test and explore them by analysis.

By way of a final point about deliberative decision-making – that is, the application of a standardised formula like the UK emergency services' Joint Decision Model – it should be remembered that all such models have inherent artificialities. Whatever their strengths (and they are many), they nonetheless impose a staged, linear and essentially bureaucratic process on the mind. It follows that they have the potential to create staged, linear and bureaucratic thinking, in crises that actually need adaptive, creative and non-linear thinking. This is not a criticism of the JDM or any other model; they are developed and have been adopted for good reasons. But, as with every other tool – their limitations should be understood along with their advantages.

Whether intuitive or deliberative approaches are used (or a combination of them), we suggest that it is critical that the outcomes are written down. This is a mundane recommendation, but an important one. It supports the need to have a record, demonstrates the rational and defensibility of the decision and assists with post-operational analysis and lesson learning. But, more critically, it also obliges people

to think very clearly and express themselves accurately. In the words of US industrialist Lee Iacocca:

> *In conversation, you can get away with all kinds of vagueness and nonsense, often without realising it. But there's something about putting your thoughts on paper that forces you down to specifics. That way, it's harder to deceive yourself, or anybody else.*
>
> (Roberto, 2008)

Figure 5 is the first of two overlapping circle, venn-type diagrams in this paper, both of which illustrate different dimensions of the tension between competing forces in how we see and think about specific situations and the wider world. *Figure 5*, below, summarises the work by Snook (2002), on perception, interpretation and decision-making in highly volatile, ambiguous and complex environments.

> *There is always an easy solution to every human problem – neat, plausible and* wrong
>
> (Henry Mencken, 1880-1956)

Snook's work centred around the accidental shooting down of US army helicopters by the US Air Force over Northern Iraq in 1994, and ranges widely across how we interpret and make sense of evidence, especially when under pressure. His essential conclusion is that we are almost always managing three competing forces, as illustrated in *figure 5*, and that we have a general tendency to adopt explanations that accord with what we *expect* to see, and especially when they line up with what we *want* to see, even when this involves highly selective filtering and arrangement of the evidence to support that position.

Figure 5: a basic model of sensemaking (Snook, 2002)

Box 4 details the case flawed sensemaking by the US Navy in the shooting down of Iranian airliner IR655 by the USS Vincennes in 1988, and the parallels are clear.

CONTEXT TO THE ENGAGEMENT	DETAILS OF THE ENGAGEMENT	ISSUES ARISING
• US Naval intelligence had been received that raised the threat level and expectation of possible attack from Iranian forces • The USS Vincennes had altered course to engage Iranian gunboats after they opened fire on its reconnaissance helicopter • The crew on the USS Vincennes were subject to distraction and noise from the engagement with Iranian gunboats, complicated by an equipment malfunction on one of the ship's main guns, forcing a rapid change in course • During the time of the surface engagement Iran Air Flight 655 (IR655) took off from Bandar Abbas, an airbase that was used by both civilian and military aircraft • The departure of IR655 from Bandar Abbas was delayed by approximately 30 minutes, which meant that although it was flying in a recognized civilian air corridor, no flight was scheduled to be there at that time. This was further complicated by uncertainty as to whether the commercial flight schedules held on the ship were referenced to Bahrain time (as used on the ship) or the local time at Bandar Abbas, the origin of the flight. The conclusion drawn by the US crew was that no commercial aircraft was supposed to be there at that time. • There was a recent precedent in the memory of the US crew in the attack, by Iraqi aircraft, on USS Stark in 1987 with death of 37 US sailors, an attack for which the ship's commanders were held responsible and punished	• There was ambiguity over the IFF codes being associated with the unknown aircraft (i.e. IR655) which did not allow the US sailors to definitively identify it as a commercial flight, an aspect that was later attributed to human error as a sailor in the Combat Information Centre (CIC) wrongly attributed the IFF code of an F14 aircraft at Bandar Abbas to IR655. They were in fact two separate aircraft. • There was a failure to establish communications between USS Vincennes and IR655 – no response was received to ten warning messages. Seven of these however were transmitted on a military radio channel which a civilian aircraft would not be able to receive, and the three on the civil aircraft distress channel did not clearly identify which aircraft they were directed at. The warning messages referred to the speed of the aircraft, but these were in ground speed, and air speed is substantially different • There was erroneous situational reporting within the CIC, in particular the repeated reference to the descending altitude of the aircraft, perceived in the CIC as an attack profile prior to missile launch. IR655 was in fact ascending during the whole encounter, and a failure of senior officers to challenge the reporting of more junior officers was a major failing identified in the subsequent USN inquiry. • The unknown aircraft (i.e. IR655) was labelled on the displays in the CIC as 'F14', rather than a more ambiguous label that would have reflected its unknown status. • During the review, which had access to all CIC transcripts, no inaccurate data was found on any of the CIC systems. The uncertainty and error had arisen through fearful, expectation-driven interactions between trusted team members under conditions of stress, distraction and noise.	• There was a vivid risk apparent to decision makers due to the precedent of the attack on the USS Stark in the previous year • Conflicting information faced decision-makers, although opportunities to resolve critical uncertainties were not taken • The whole action can be usefully seen as error in a socio-technical system, in which data flows and ergonomics played a role, but expectation-driven cognition and behaviour dominated events • Time pressure was acute: IR655 was only airborne for seven minutes, and decision makers were juggling multiple perceived threats from the surface as well as the air • The framing of the threat was critical – once the team in the CIC had labelled the unknown aircraft as an 'F14' then it was both regarded and treated as such • The episode is fundamentally a tragic example of confirmation bias or 'scenario fulfilment' (the US Navy term adopted in subsequent reviews) in action. • It was subsequently revealed that the USS Vincennes had entered Iranian territorial waters during the engagement, a fact that indicates degraded situational and strategic awareness by the US crew.

Box 4: a failure of sensemaking in the case of the USS Vincennes and IR655

The process of making sense of evidence, inverted by some researchers as 'sense-making' (Weick & Sutcliffe, 2001), is intimately related to the cognitive processes of heuristics and biases. A heuristic is a cognitive shortcut, or rule of thumb that allows us to form inferences, draw conclusions, solve problems or make decisions without recourse to systematic analysis of all the evidence (Gigerenzer et al., 1999). They can provide people with good approximate answers under a range of circumstances and are the basis for intuitive reasoning. They key point here is that "good approximate answers" that are timely usually serve better than complete answers that arrive too late.

Specific heuristics have however been associated with particular biases. For further information, appendix C summarises some of these shortcuts and their associated shortcomings.

Context is an important dimension of sense-making as well, and provides a framework within which heuristics and biases work. Bennet (2003) illustrates the power of context. He set out he analyse how a number of US warships fought a running battle, over a number of hours, in darkness and bad weather, against what they thought was a fleet of attacking North Vietnamese gunboats in 1965. In fact, there were no gunboats and no other vessels in the area at all. This was the celebrated Tonkin Gulf incident, in the early escalation phase of the Vietnam War.

Poor conditions, ambiguous data, confusing information, heightened tension, a recent spate of confrontations and an expectation of being attacked all combined to convince the Americans that they <u>were</u> being attacked – when in fact the "enemy" was nowhere near. Analysing this event, Bennet described its context in the form of the immediate, the proximate and the distant factors which influenced this example of spectacularly flawed sense-making. Interestingly, this may correspond loosely with the operational, tactical and strategic layers of response in crisis and emergency management. In other words, flawed sense-making at one level of response may easily "infect" the other layers; sense-making is a holistic effort.

The body of work on human error is far more extensive than we can cover here (for two good overviews see Dekker (2011) and Reason (2008)) but we have covered the main ways in which *thinking failures*, allied with the three processes that develop situational awareness – perception, comprehension and projection – can lead to difficulties. Two premises were set out in the executive summary, a) that there is inherent uncertainty in a crisis that even high levels of performance can only reduce slowly, and b) we all generally commit cognitive, behavioural and collaborative lapses which may impede situational assessment, or may even further muddy the waters. This distinction echoes that of Gawande (2010) in his book on checklists between *errors of ignorance* (mistakes we make because we don't know enough), and *errors of ineptitude* (mistakes we make because we don't make proper use of what we know).

There is no silver bullet for the human tendency to err, whatever the proximate or underlying cause of that error. The paper so far has focused on how we as individuals can err, whether by a failure to rigorously manage information, or through

cognitive lapses in making sense of that information. The remaining sections of the paper suggests principles, good practice and specific tools and techniques that can support a deliberative approach to situational assessment, both individually and in a team and team-of-teams setting. Before that the specific challenges associated with attaining shared situational awareness are set out.

8. *Shared* Situational Awareness

Decision-making needs to be understood at three levels: the individual, the team and the organisational (or team-of-teams). Situational awareness is an individual cognitive state. There is an attractive simplicity about the term 'shared situational awareness' that implies a neat and complete sharing of what we know, understand and can project about a particular situation. The reality is rather less neat. Situational awareness is not "everything I know", it is "what I know about this situation", and the role of mental models and schema in forming and framing this has been discussed in section N. So, just as individual SA is context-specific and objective-oriented, shared SA (SSA) is best understood as the knowledge and understanding that is (*or should*) be common to all those involved in a situation in order to enable an effective, collective response. Endsley and Jones (2013) refer to *team SA* rather than *shared SA*, but their comments relate to the same thing:

> *SA, in that it is a cognitive construct, is not something that a team can possess as a whole. There is no "suprabrain" of a team that can have awareness of anything. Only the individuals within the team can have awareness. Team SA, therefore, must be embodied by the SA of individual team members* (p.195)

This is reflected in the basic model of SSA, illustrated below (*Figure 6*).

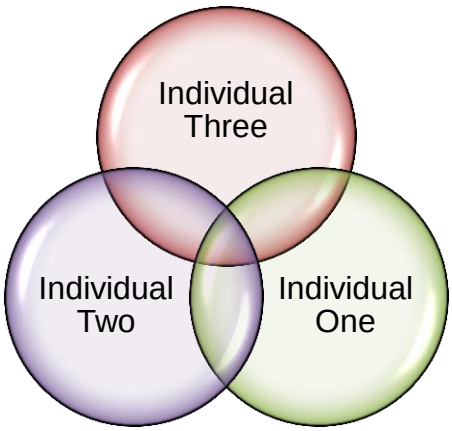


Figure 6: SSA as the Overlap Of Individual SA – a neat model, but practically how do you ensure that the overlap is sufficient and genuinely shared between individuals?

The key point of *figure 6* is that the areas of overlap (it's very schematic, so don't worry about the relative proportions) represent the areas of robustly shared knowledge (e.g. it goes far beyond having access to the same facts and requires that

their meaning and implications are commonly understood). What, and how much, is shared depends upon the common objectives which the group are working to attain, and the level of interaction and interdependence between them in doing so. For example, if tightly nested collaboration is required then the degree of overlap will be greater than for organisations which only require sharing of risk information to ensure safe working in parallel with each other.

It is important to emphasise that shared situational awareness does not imply that *everything* that is known by involved parties should be shared. This would be grossly inefficient and not everybody needs to know everything. There was an advert for the AA (as in the Automobile Association) in the late 1980s with the strapline *"Can you fix it? No, but I know a man who can",* and this is fundamental to what some researchers have termed 'Joint Situational Awareness'. This slightly different concept accepts that what matters most is that the knowledge of participants is shared to an extent that allows it to be effectively deployed, within the context of a collective effort. This might mean that sub-groups form around specific tasks and so need to share a great deal of information, while the wider groups need to know much less, or much more about something else. From this perspective the level of SA overlap is variable between individuals and groups, but having *enough* Joint SA to operate coherently is the priority.

Attaining SA involves choices about information, and it is established that individuals' choices are prone to the influence of a variety of factors, heuristics and biases that can warp the outcome. If we extend this to shared SA, does it not follow that two (or more) heads are better than one? Unfortunately, this is not always the case. The fact is that teams can be – but sometimes aren't – better at it than individuals. Why is this so? The key work in this area was done by Janis (1982), who popularised the concept of groupthink. Most readers will be familiar with the idea, but it centres on the tendency of teams to seek harmony and conformity – minimising conflict to reach a consensus by either avoiding critical analysis of alternatives or actively suppressing dissenting views. Janis pointed out that groupthink is a characteristic feature, not of weak teams that are dysfunctional *per se*, but of those which are cohesive and under stress. This has obvious implications for emergency and crisis management teams.

It also resonates with the work of Vaughan (1996) on the "normalisation of deviance" – the subtle, incremental adoption by teams of positions and policies increasingly at variance with supposedly "accepted" norms and practices - particularly in risk management. Roberto (2009) called this effect an incremental descent into bad practice, and it is a potential risk in sense-making and decision-making at the organisational level.

Surowiecki (2004) argued that teams can be better than individuals at choice-making, providing:

- They are diverse, with a broad range of well-developed subject matter expertise.
- They are decentralised and consist of empowered, independent individuals – with no dominant party holding sway by virtue of office, prestige or egotism.

- They operate a mutually understood and accepted process for aggregating results and arriving at a conclusion.

This all reflects the reality that decision-making in teams is a social process, and like any other form of social interaction there is good practice, and there is bad practice. Knowing the most appropriate form of behaviour and leadership to make best use of the human resources available to you in a crisis is a matter of social judgement and self-awareness rather than a simple set of rules to follow. That said, the principles and good habits set out in this paper represent a very good starting point.

Naturally, we tend to believe that – given the right leadership and support – our teams will perform well and thoroughly and intelligently explore all the different aspects of an issue before deciding on a course of action. In other words, they will make sense of the situation and pool their collective talent and expertise to do so. However, the reality is somewhat different. Leadership is one factor here and it is closely related to the phenomenon of groupthink (see above). There is also the issue of what Stasser and Titus (1985) call "common" and "private" information.

"Common" information is broadly generic and readily accessible by all members of the team. "Private" information is what sits in the specialist domain and specific expertise of individuals. What these researchers saw was that "common" information tends to be discussed in teams much more, and at greater length, than "private" information - even when the latter is of obvious importance. In particular, they saw that lower-status team members are often less than eager to share deep subject-matter expertise with the team. It seems that:

> *The bearer of unique information, like the bearer of bad news, incurs some social costs …(like) the necessity of establishing the credibility and relevance of unique information.*
>
> Roberto, M (2009)

Since niche specialists are usually brought into teams specifically to provide their expertise, it is interesting to see research that suggests that it isn't typically examined to the extent one would expect, or given the "air-time" it may deserve. The implication for team members is self-evident, but especially for leaders and specialists: overcoming a natural tendency takes a specific act of will.

8.1. Other Pitfalls And Barriers To Shared Situational Awareness

Shared SA is difficult to achieve, and all of the inherent uncertainties and obstacles that limit individual SA are operating in the background. Interaction between individuals, teams and teams-of-teams then impose a further level of friction, and *box 5* illustrates some common barriers to the attainment of shared situational awareness.

Some common barriers to attainment of effective shared situational awareness:

- concepts are not commonly understood
- terminology is not commonly understood
- different metrics and measurements are by different teams, but this is not known
- baseline conditions or denominators are not commonly understood
- graphical representations (e.g. signs and symbols) are not commonly understood
- assumptions which are valid within teams are made about other teams and then go unchallenged, or even unacknowledged
- operating procedures and objectives of one team are not understood by others
- information required by one team is not shared by others
- expertise held by one team is not made available to the collective effort
- challenge and critique is suppressed by dominance by one person/team
- the above develops into groupthink and pressure on members to conform
- leaders may do not give the team space to think of or to propose alternatives
- the "natural" or institutional authority of the leader's interpretation frames the issue for the members, limiting debate (and possibly disclosure).

Box 5: some common barriers to the attainment of shared situational awareness

Figure 7 below serves as a clear reminder that, as with data and information, words can often be less than neutral; their meanings can vary considerably from one reader to the next. In some cases, the research findings suggest that when a situational assessment (or a prediction or risk assessment) uses a word such as "probable", there is no guarantee that the reader or recipient will place a meaning on it similar to what the writer or speaker intended. This is clearly a problem for shared SA. There is no easy solution, other than to be careful in the choice of words, check that there is a mutual understanding of what is meant and to challenge assumptions about commonality of meaning when shared understanding is critical.

Term	Research findings from Lichtenstein and Newman (1967)		Research findings from UK Government Crisis Training Attendees (n=367 at May 2014)[3]			Research reported by Heuer (1999)	Associated probability range from UK PHIA (2009)
	Mean %	Range	Mean %	Range	Std Dev	Range	Range
Unlikely	18	1 – 45	16	1 – 90	13	2 - 35	15 – 20
Probable	71	1 – 99	64	10 – 95	18	50 - 95	55 - 70
Possible	37	1 – 99	45	1 – 90	18	5 - 55	-
Likely	72	25 - 99	72	10 – 99	18	60 - 90	55 - 70

Figure 7: Percentage values attached to Words of Estimative Probability from four sources including primary research by Robert MacFarlane

[3] *Ongoing survey work amongst local strategic and central government emergency management course attendees. Figures rounded to nearest whole number.*

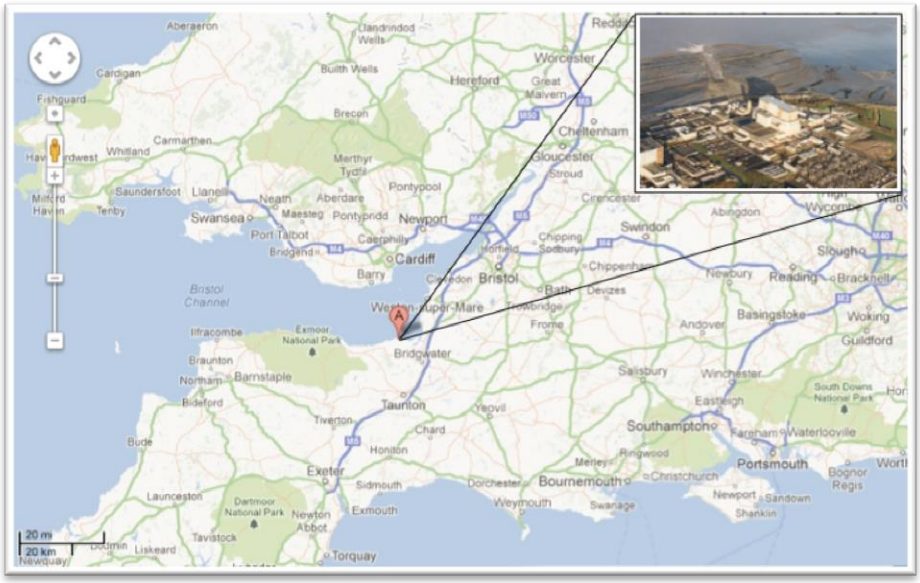


Figure 8: an ambiguous map used in the scenario for a nuclear release exercise.

Figure 8 above was used in a scenario exercise involving an unknown level of radiation release from Hinckley Point in North Somerset. The map was intended to show only the location and aerial view of the release site. The converging lines used to illustrate the location of the aerial photograph map were interpreted by an experienced public health professional with extensive experience of radiological issues as a plume map, indicating the distribution of contamination, triggering a discussion about whether or not to evacuate Bristol. This was in spite of the fact that the wind direction stated in the scenario was easterly i.e. from right to left in the map, taking any release generally *away* from Bristol. The issue is not whether it was a bad map, or a bad case of misinterpretation, rather it is a neat illustration of how what is intended by the provider of a piece of information can be interpreted by a recipient in a wholly different way.

Similarly modelled data can also serve to fixate people. In another example, senior responders given a toxic release plume map in an exercise were seen to repeatedly disregard or discredit isolated reports of people with potential gas poisoning because the reports came from places outside the zone shown on the plume map. This is an example of the modelled data actually serving as a limiting frame for those using it. The interesting point is that the responders did understand, in principle, that the map was nothing more than a probability estimate. But in a situation of uncertainty and pressure on sense-making, it acquired an unintended level of significance and authority – because they had very little else to go on and tended (culturally) to associate maps with accuracy and reliability.

9. Managing Information For Shared Situational Awareness

Garbage In – Garbage Out (GIGO) is well known as a potential pitfall of uncritical assessment in information management. This is especially acute in the context of multi-agency or cross-boundary working where uncertainties about information

quality can be compounded by different practices, norms, tolerances, metrics and terms, so that what makes perfect sense within one organization makes next to no sense to another (or makes perfect, but completely different, sense). In the multi-agency context information often passes across boundaries as it moves from the 'front line' to higher-level coordination groups. When this happens information management is best thought of as a supply chain and a failure to add value where there is the competence to do so will dramatically weaken the evidence base. The effect on end-users is that they get a bundle of ingredients but no usable (or in *figure 9*, edible) product.

Figure 9: information management as a supply chain – organisations in that chain must add value and do what only they can do

Where data and information are being passed up a chain without adding value through assessment, triangulation, analysis or interpretation then the evidence base for response will be stuck with weak answers to the *what?* question (see section 4), without tackling the important *so what?* and *what might?* questions.

9.1. Tools To Support Deliberative Situational Assessment

> *Thinking sometimes has to be made artificial and deliberate otherwise we take it for granted and assume that we do things when in fact with do not do them at all*
>
> (de Bono, 1995)

Metacognition is cognition about cognition, or more colloquially thinking about thinking (Davidson et al., 1994). It has been studied from a variety of perspectives, but in the field of cognitive psychology it is used to describe a sense of critical self-awareness in reasoning that encourages checking, exposing assumptions, methodologies and conclusions to external review, and active learning. The culture of some organisations can place a heavy emphasis on intuition as 'compressed expertise' (Klein, 1998) and consequently may not welcome, or find it easy to adopt more structured ways of thinking such as decision frameworks or tools. In many naturalistic settings intuitive approaches often work well when faced with relatively immediate and self-evident problems, and individuals operating in such environments typically accumulate extensive experience to hone their mental models for intuitive decision-making. Intuition, to be successful however, is rooted in relevant knowledge. Where decision makers are faced with a situation that they do not have relevant

specific knowledge for, they will need help to make sense of what is happening and what to do about it.

A wide variety of decision tools and techniques have been developed in a range of different contexts, although the rekindled interest of the intelligence community in formal, analytical techniques and cognitive self-awareness following the failures associated with Weapons of Mass Destruction and the 2003 invasion of Iraq is particularly noteworthy (CSI, 2009; Davis, 2008; Heuer and Person, 2011; Heuer, 1999; MOD, 2013a; Pherson Associates, 2008). A number of references are given because many of the tools described in these volumes are readily applicable to a range of other risk, emergency and crisis management contexts. *Table 4* lists some of these techniques and tools and for further details on these please see (EPC, 2011).

Tools	Potential Application Areas
Imaginative thinking techniques and tools to facilitate thinking and collaboration	
Mind maps	Exploring the different, linked elements of an issue in a diagrammatic, non-linear but structured way. The aim is usually to tease out connections and interdependencies that might not appear so readily in a linear, list-based approach.
Brainstorming	Identifying the different, linked elements of an issue and its implications by open, non-judgemental free discussion – where ideas and thoughts are captured without immediate comment, analysis or evaluation. The aim is simply to capture all the dimensions/aspects of the issue on paper for <u>later</u> evaluation and analysis.
Analogies	Identification of similar, previous cases that might be able to guide managers as to suitable courses of action in a contemporary situation. It is <u>not</u> a slavish re-application of something that was done in the past; the previous case is treated as an analogue, not just as an earlier occurrence of the same problem.
Idea spurring questions	Questioning designed to provoke the exploration of alternative understandings, consequences and future choices – and to challenge or extend thought processes and current analyses. Useful as a general sense-check when teams begin to converge (perhaps too readily) and as a periodic check that assumptions, objectives and the like are still valid.
Diagnostic techniques and problem decomposition tools	
PESTLE and derivatives	Factorisation of a problem in order to improve understanding of its different aspects. Involves breaking it down according to its component factors under headings such as **P**olitical, **E**conomic, **S**ocial, **T**echnological, **L**egal, **E**thical/**E**nvironmental.
Risk Matrix	Visual comparison of the relative magnitude of evaluated risks on a matrix
Fault trees	A deductive process in which system failures are analysed to combine the effects of a series of lower-level events. This method is mainly used to understand how systems can fail, and to identify

	the best ways to reduce the risk of failure.
Persistent questioning	The discipline of constantly asking a cycle of questions to check, confirm and refine situational awareness and ensure that it keeps evolving and maturing as the situation develops. We suggest that the persistent questioning drill is the continuous cycle of asking: • What has happened? • What is happening now? • What is being done about it? • What has not or is not yet happening? • What are the likely impacts and risks of this situation? • What happen in the future (Leigh, MacFarlane and Williams, 2013)
Root Cause Analysis	Identification of the fundamental "trigger" of a situation, by working back through a system's failure to identify a root cause.
Impact trees	Identification of the various, related impacts of an event or a risk, using progressive levels of detail through primary, secondary, tertiary (and so on) impacts. This is useful as a response management tool (to reduce the number of "surprises" the team may face, but also for identification impacts for a risk assessment and for generating plausible exercise scenarios.
Contrarian techniques and evidence testing tools	
Known-Unclear-Presumed	Separation of the known from the unknown/unclear and the presumed.
Assessing source and credibility	Validation by provenance and source-authority.
Devil's advocacy	Checking by alternative analysis – usually involves deliberately challenging any point or conclusion thought to be taken for granted or "generally accepted" (MOD, 2013).
Assumption testing	Surfacing, acknowledging and testing underpinning assumptions – and identification of the "load-bearing" ones that needs to be most carefully examined
Option and Choice Tools	
Weighing pros and cons	Visual presentation (by side-by-side lists) of the factors for and against a choice.
PMI analysis	An extension of pros and cons. It means listing what is desirable (**p**lus) about a course of action or choice, what is less desirable (**m**inus) and what is worth more investigation (**i**nteresting). Hence PMI.
Force Field Analysis	Identification/visualisation of forces acting in support of, or opposition to, a plan or policy. It can graphically demonstrate the balance between for and against factors.
SWOT	Identification of strengths, weaknesses, opportunities and threats contingent on an organisation, decision or course of action. Conventionally, in organisational resilience terms, opportunities are

	the products of strengths and threats are associated with the organisation's weaknesses.
Bow Tie Diagrams	Consequence mapping, with the facility to represent mitigation strategies in bow-tie-style layout with the root cause in the middle – at the knot of the tie.
Scenario Approaches	"What if…" modelling, to test preparedness, risk assessments and potential strategies against a range of hypothetical cases.
Frame analysis	A research method used to analyse how people understand situations and activities (do sense-making) in terms of "frames". In communications studies, it usually refers to the way information is manipulated and presented to achieve a given influence over opinion.
Decision Trees	Mapping future choices that could arise depending on the stage-by-stage results of a strategy already under way.
Dilemmas and tradeoffs	Identification and evaluation of "least bad" options when no "clear win" option is visible.
Two simple prioritisation tools	1. Must do, should do, could do, would like to: prioritisation according these categories in order of importance. Sometimes called Moscow analysis, for MoSCoW. 2. What is urgent? What is important? Urgency and importance are expressed as high or low on a conventional 2 x 2 Boston matrix. Reflects the truism that what is important is not always urgent, and vice-versa.
Timeline	A timeline allows planners to sequence actions over time in a visual way – and concurrently. They are very useful in establishing timeframes when one action cannot start until another is complete, or when working backwards to phase and stage the subordinate tasks necessary to complete an action or set up conditions for the next stage of activity. A related tool is the "last safe moment" concept. This involves working out the last moment that an action has to start or be completed by, to support the overall plan and keep it on schedule. It may also refer to the time beyond which a decision cannot be delayed.

Table 4: decision tools of potential utility in risk and crisis management

Checklists do not sit neatly in any of the types listed above, and they may be used as an element of many of them.

A CHECKLIST is a list of actions to be taken and/or issues to be considered in a complete and consistent manner.

Note: checklists do not capture all the required knowledge for a particular task, but they can compensate for lapses in memory and attention and provide a framework for disparate individuals to work effectively together.

Checklists are not universally approved of, with some criticising them for reducing tasks to thoughtless and robotic processes. Others, notably Gawande (2010), have

promoted their use in ambiguous, volatile, high-risk and complex environments where the potential for error is high and the consequences of error are serious. The most common form of checklist is the 'to do list', a set of tasks to be done, probably timed and possibly prioritised. They are written down to compensate for the human tendency to forget, overlook or be distracted, and as such they are a pragmatic response to an acknowledged weakness. Airline pilots use checklists for both routine and emergency procedures for essentially the same reason, and Atul Gawande (2010) has elaborated his experience, and the life-saving consequences, of adopting surgical checklists in a healthcare context. In addition to 'do this' checklists, there are 'think about this' (or 'have you thought about this?') type checklists. It is argued here that the latter, termed *consideration checklists* as distinct from *action checklists*, have a considerable utility in the context of attaining and assuring situational awareness. Action checklists have the advantage of enabling a rapid response to foreseen, bounded and well-understood problems, but with the risk that if there is a weak fit between the problem as it is understood and the problem as it is experienced, then actions following a checklist could waste effort or exacerbate the situation. Approaches that enable responders to collaboratively build an understanding of the situation (as distinct from select a best-fit model of the situation), tackle uncertainties, challenge assumptions and address ambiguities may feel slower, but promise better situational appreciation under crisis conditions.

Appendix B sets out a consideration checklist for teams working to establish shared situational awareness, and it is summarised in *Figure 10* below.

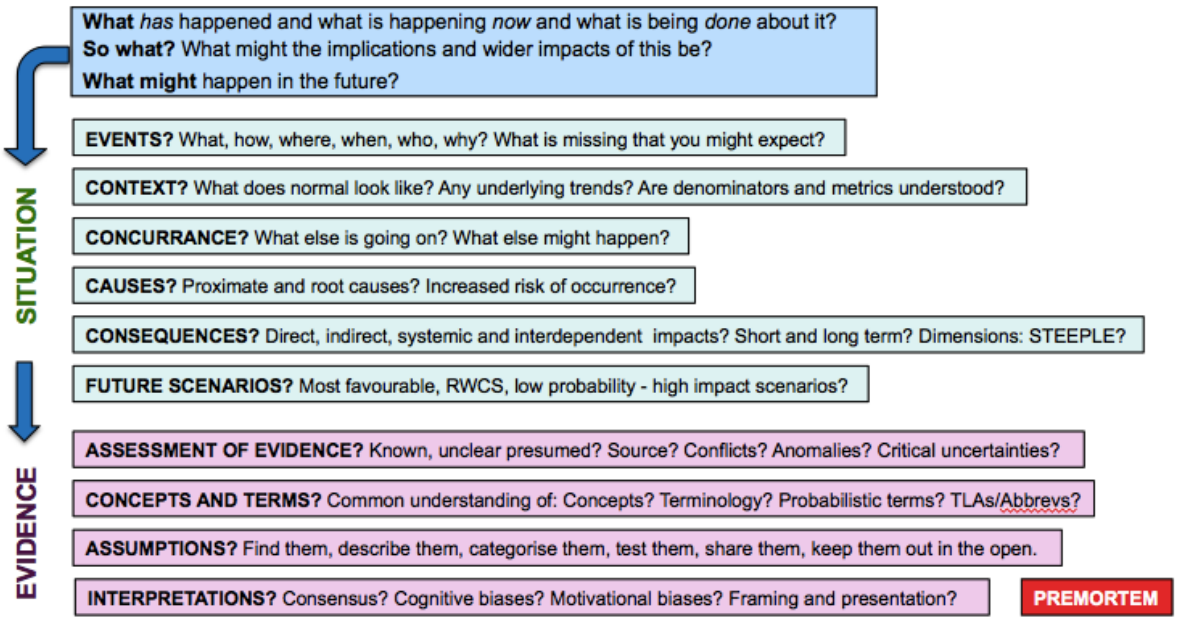


Figure 10: summary of the questions that drive situational awareness.
*See **Appendix B** for the full consideration checklist.*

10. A Common Operating Picture

10.1. Recap: Information Management And Shared Situational Awareness

Figure 11 summarises the earlier sections of this paper, in which the importance of a systematic and critical approach to information management was established and the concepts of individual and shared situational awareness and factors that hinder the attainment of both were set out.

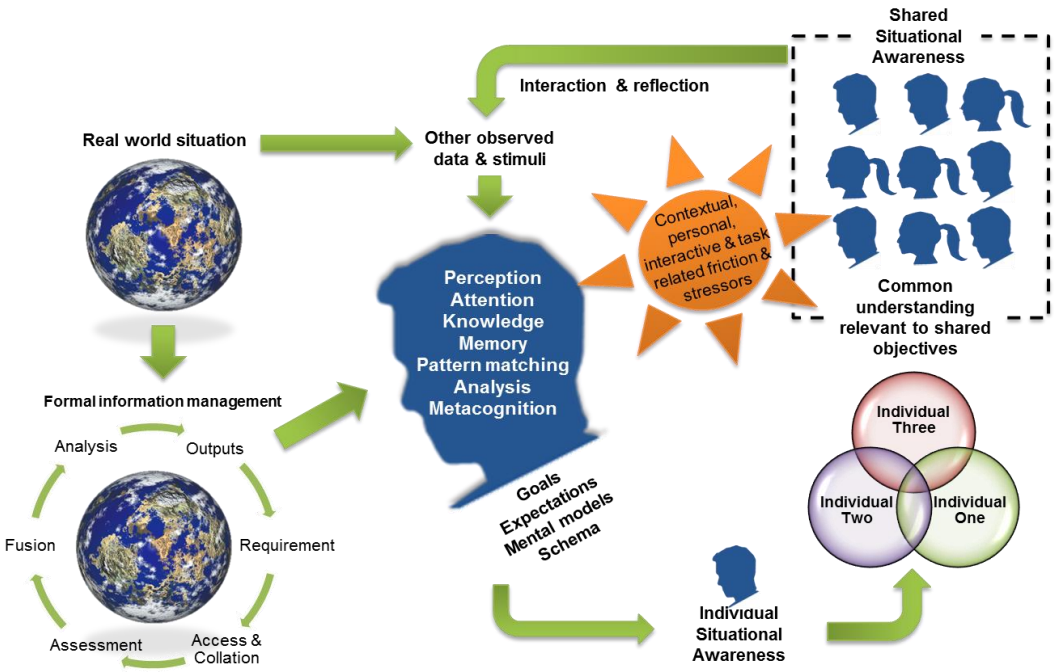


Figure 11: Relating Information Management, Cognitive Processes And Stressors To Individual And Shared Situational Awareness (based on Endsley, 2000)

Outputs from the formal business of information management are filtered by our individual cognitive processes, experience and habits and thereby create individual situational awareness that may be more or less in step with the real world situation. Stress, of various types, is an ever-present complicating factor in crisis management.

10.2. Can Situational Awareness Be Displayed?

SA is a label for a phenomenon that is unique to each of us as individuals at a given point in time, at which our perception, comprehension and projection of events intersects with our prior experience, knowledge, skills, expectations, preferences and general worldview to form a sense of what is happening, what it means, what might happen and what we do, or might, need to do about it. This is a general description of SA, based on academic research and its practical application, but it is not a neurological or cognitive psychological explanation of how our brain operates, something that is definitely outside the scope of this paper.

Some have represented SA as a product, or something tangible that can be displayed or transferred. For example Radke *et al.* (2013), writing about the potential of Geographical Information Systems (GIS) to 'enable comprehensive situational

awareness', refers to the creation of 'a series of role-based situational awareness viewers' (p.5). While GIS have a potentially very significant contribution to make in this context, the claim being made treats SA as something you can see on a screen. We reject that claim, and point to the overwhelming evidence that SA is developed by individuals as they interact with information and other people to make sense of events – it is not something that can be emailed or displayed on a screen. Similarly Treverton (2010) has argued that:

> *While the first approaches to knowledge management tended to treat knowledge as a durable object that could be transferred, stored, accessed, and used - in short learned - sense making treated knowledge as an ephemeral social construction that must be created, is difficult to move across boundaries ("sticky"), is "decontextualised" in moving from one context to another, is subject to decay and destruction, and must be "reaccomplished" from day to day (p.352).*

The concept of a Common Operating Picture (COP) has become more widely used in recent years, and we offer the following definition:

> COMMON OPERATING PICTURE: an overview of an incident, created by assessing and fusing information from multiple sources to support decision-making.

The actual form of a COP will vary between organisations and contexts. Some will be graphical or map-based, others more textual, some will be interactive and others static, and some will emphasise real-time data and others will include only validated data, thereby imposing a time-lag on inclusion. A COP that is appropriate to the operating context is a powerful point of reference for the attainment of shared situational awareness.

That display, point of reference or entry point into relevant information will only enable the attainment of shared SA when all parties think and behave in ways that are truly collaborative. The COP is a product, an output or a structured display of information and SSA is what we hope to achieve in the heads of all those working together, to a common end, in a joint response. This kind of shared knowledge and insight is built not just by the provision of information, but also interacting through asking questions, clarifying uncertainties, challenging assumptions and so on, which is why in central government training we give such emphasis to the behavioural aspects of working together and across boundaries, with the available information, to build SSA as the basis for multi-agency decision making.

11. Summary And Guiding Principles For Decision Support In A Crisis

This paper set out to describe and relate information management and situational awareness, and emphasise the cognitive and behavioural dimensions of attaining shared situational awareness in the specific and highly demanding context of crisis

management. Having summarised the concepts and research in the field, we propose a simple model of individual situational awareness, which is having appropriate and meaningful answers to the three questions *what?, so what?* and *what might?* Individual situational awareness is the basis for shared situational awareness, as those involved work together to contribute facts, context, insights, interpretations and apply techniques, skills and challenge. Through this social and cognitive process shared situational awareness is developed, and in turn the process of reaching shared situational awareness will advance or otherwise adjust the situational awareness of involved individuals (*figure 12*).

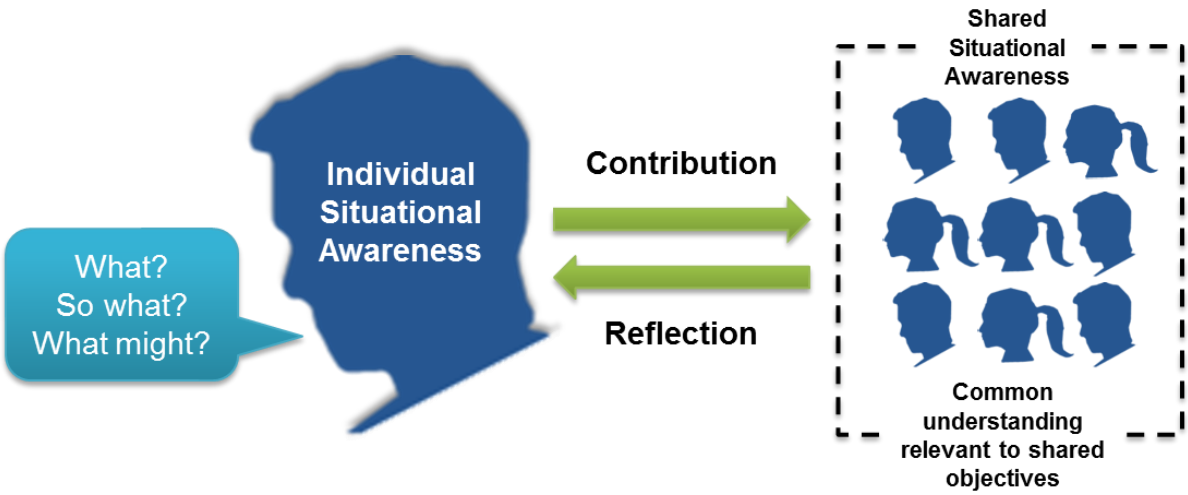


Figure 12: there is a dynamic relationship between individual and shared SA

We conclude through offering some principles that will guide decision support staff and crisis decision makers in preparing for and responding to a crisis. These are:

a) **Information is a vital asset** in managing a crisis – design ways of working that will support foreseeable demands yet be flexible enough to adapt and scale to respond to unforeseen demands.
b) **Information management is a supply chain – add value at the point of competence:** adding value means answering not just the *what?* question, but the *so what?* and *what might?* questions as well.
c) **Senior and strategic decision makers require a team to manage information** and support situational awareness – decision makers cannot effectively and meaningfully do it themselves.
d) **Situational awareness will not build itself** – it needs a concerned, proactive, collective, mindful, challenging and sustained effort.
e) **Situation awareness is not a product – you cannot give it to somebody else:** situational awareness is fundamentally an individual cognitive state, and while you can pass data and information by email, paper or speech, shared situational awareness is attained by two way interaction to establish common ground in the context of shared objectives.
f) **Thought, behaviour and communication adds meaning to process –** moving data and information around is not the whole story; think about

what you are doing, why and how it contributes to the attainment of shared objectives.

g) **Assumptions will be necessary, but they need to be treated with great caution:** find them, express them in plain English, share them, test them wherever possible and keep them out in the open.

h) **Terminology and graphical representation is not usually commonly used or understood,** especially where a crisis response spans boundaries between teams or organisations. Language is essential, but different people and different organisations may attach different meanings to the same things. Don't assume you mean the same thing, even if you are using the same words – find out what others mean and tell them what you mean.

i) **Challenge, and be prepared to be challenged:** even high performing teams can become convergent at times, and a range of contrarian techniques, from devil's advocacy to formal red teaming, can expose premises, assumptions, approaches, conclusions and modes of communication through 'outside in' thinking.

j) **Stress makes everything more difficult and prone to failures:** people make mistakes at the best of times, and stress makes various forms of error more likely. You need to actively check for mistakes in your own thinking and working, do the same for others, and get others to check for you.

k) **Structured ways of working promote defensible decisions:** while intuitive decision making is highly appropriate in certain contexts, multi-agency teams tackling inherently uncertain problems are best advised to adopt a structured and rigorous approach, rooted in the Situation – Direction – Action framework set out in this paper.

These general principles will be tested in years to come by technical and data developments that are likely to transform what we can display, and how, in support of crisis decision makers. Rapidly sourced satellite data is increasingly available to civilian responders, crowdsourcing techniques and rapid data collection using handheld devices from the front line are commonly used in international disaster relief operations, and future digital platforms offer huge potential for enhanced data transfer. However, these general principles will stand because more inputs and greater automation in its various forms are ultimately mediated through and applied by people, and it is their self-awareness, intelligence and ability to challenge and interact that ultimately makes sense of events.

Appendix A: Glossary Of Terms

Notes:

i) in this paper the terms crisis (management) and emergency (management) are used interchangeably, as the principles and good practice set out here are applicable wherever multiple organisations (or parts of large organisations) come together to manage serious disruptive events. Precise definitions appear below.
ii) For the authoritative lexicon of UK civil protection terminology please search for 'civil protection lexicon' at www.gov.uk

Term	Definition	Source
Alternative analysis	The deliberate application of independent critical thought and alternative perspectives to improve decision-making.	NATO definition referenced in MOD (2013b)
Common Operating Picture (COP)	An overview of an incident, created by assessing and fusing information from multiple sources, to support decision-making. Note: the actual form of a COP will vary between organisations and contexts. Some will be graphical or map-based, others more textual, some will be interactive and others static, and some will emphasise real-time data and others will include only validated data, thereby imposing a time-lag on inclusion.	CCS (2014), derived from FEMA (2008)
Commonly Recognised Information Picture (CRIP)	A single, authoritative strategic overview of an emergency or crisis that is developed according to a standard template and is intended for briefing and decision-support purposes. Note: within COBR the CRIP is typically collated and maintained by the Central Situation Cell and circulated where relevant to responders	UK CP Lexicon
Crisis	An abnormal and unstable situation that threatens the organization's strategic objectives, reputation or viability	BS11200
Crisis management	The development and application of the organizational capability to deal with crises	BS11200
Emergency	An event or situation which threatens serious damage to human welfare in a place in the UK, the environment of a place in the UK, or the security of the UK or of a place in the UK.	UK CP Lexicon
Emergency management	Multi-agency approach to emergency management entailing six key activities – anticipation, assessment, prevention, preparation, response and recovery	UK CP Lexicon
Geographical Information	Computer based system that supports the capture, management, analysis and modelling of geographically	

System (GIS)	referenced data	
Information management (IM)	Integrated management processes and services that provide exploitable information on time, in the right place and format, to maximise freedom of action.	Ministry of Defence JDN06
Interoperability	The extent to which organisations can work together coherently as a matter of routine	JESIP Joint Doctrine
Shared Situational Awareness (SSA)	The degree to which team members possess the same SA on shared SA requirements	Endsley & Jones, 1997, p. 47; 2001, p. 48
Situation Report (SITREP)	Report produced by an officer or body, outlining the current state and potential development of an incident and the response to it A summary, either verbal or written, produced by an officer or body, outlining the current state and potential development of an incident or crisis and the response to it	UK CP Lexicon BS11200
Situational Awareness (SA)	The state of individual and/or collective knowledge relating to past and current events, their implications and potential future developments. Note: collective knowledge in this context is referred to as Shared Situational Awareness.	UK CP Lexicon
Red teaming	The independent application of a range of structured, creative and critical thinking techniques to assist the end user to make a better-informed decision or create a more robust product.	MOD (2013b)

Appendix B: Summary Of Perceptual And Cognitive Biases (developed from Baron, 2008; Evans, 2007; Newell et al., 2007; U.S.Government, 2009)

Perceptual and Attentional Biases	
Bias	Comments
Anchoring	This is the tendency, when estimating a numerical value, to start from a certain value (the anchor) and then adjust away from that figure. This is a 'contamination effect' which results in values that are biased towards the anchor value. A key point is that the anchor value may be quite arbitrary and quite meaningless, yet it has been proven to distort estimates.
Representativeness	This is observed when people make judgments about the likelihood of an event, situation or circumstances on the basis of the degree to which it is regarded as being representative of a particular class. It we strongly associate specific cases with a particular class we will tend to overlook complicating or disconfirming factors such as small sample size.
Vividness	If something is vivid it is easy to recall and hard to ignore and it will influence estimations of likelihood and impact. For example if graphic images of past events are readily recalled people will tend to overestimate the prior probability of those events.
Primacy/Recency effect	When presented with a list, individuals have a general tendency to recall those entries at either end of the list more easily than those in the middle. The primacy (ease of recall of the start) and recency (ease of recall of the end of the list) effects operate in conjunction so that recall of entries or events starts high, dips dramatically and then climbs again towards the end. They are forms of the Availability Bias – whereby we tend to place excessive reliance on information that is available to us or is recent – and therefore salient in both cases.
Biases in Evaluating Evidence	
Bias	Comments
Assumptions	Assumptions exist at a variety of levels and Mitroff (2004) uses the analogy of Russian Dolls to describe the way in which they can be nested. Critically, people tend to be reluctant to abandon assumptions, even in the face of substantial evidence that they are no longer reliable, and experts can be more attached to assumptions than non-experts.
Sample size fallacy	This describes the failure to consider the size of a sample in making inferences about, or based upon, the characteristics of that sample group. Small samples may not be representative of the population as a whole, but there is a tendency to assume a greater degree of representativeness than is warranted.

Overweighting of small probabilities	Small probabilities, especially if associated with vivid events, will tend to have a disproportionate amount of significance in decision-making. Correspondingly people will tend to underweight much more high probability events.
Missing data	The term 'the absence of evidence is not evidence of absence' gained some notoriety in respect of WMD, but has wider significance, for example in risk assessment or clinical diagnosis. Mitroff (2004) describes research into aircraft armouring during the Second World War: once engineers realised that the pattern of bullet holes on *returning* aircraft was no predictor of where armour should be placed, survival rates increased.
Hindsight bias	This is the tendency to regard past events as more predictable then they might reasonably have been at the time. Chains of events in complex systems may be apparent with hindsight, but be hard to identify, and differentiate from other possible outcomes, when assessing risk.
Bias	Comments
Availability	Ease of recall influences probability estimations: when examples readily come to mind then probabilities tend to be overestimated. Conversely, when few or no examples can be recalled then prior probabilities tend to be overestimated.
Conjunction	This is judging probability of a subordinate category (P(A&B)) greater than a superordinate category (P(A)). This may be related to the existence of cognitive prototypes, a sub-set of which (in popular terms) will be stereotypes.
Base rate neglect	This describes reasoning errors arising where the baseline incidence or prior probability of an event is not adequately considered in making judgments about future likelihood.
Gamblers' fallacy	This is the tendency to overestimate future probabilities on the basis of the distribution of past events. If a flipped coin has fallen heads up 6 times in a row, the likelihood of the next result remains 50/50, but a false belief that it is more likely to be tails is widespread.
Biases in Perceiving Causality	
Bias	Comments
Pattern illusion	This is the tendency to perceive patterns such as clusters in actually random distributions.
Attribution	Individuals tend to ascribe greater significance to their decision-making and input into events than they do for others who were involved. Conversely, contextual factors tend to be ascribed greater significance to explain outcomes when others were involved.
Rational intent	People tend to attribute rational intent to the cause of events that may in fact be accidental, unintended or even random.

Motivated Biases and Wishful Thinking	
Bias	Comments
Sunk cost bias	A sunk cost is one that cannot be recovered and people tend to give undue recognition to sunk costs when considering the future efficiency and effectiveness of a particular course of action. Decision makers show a strong inclination to stick with a course of action, or perhaps escalate their commitment, even when positive long-term outcomes look unlikely.
Wishful thinking	People prefer attractive explanations and projections of outcomes to unattractive and dissonant ones, and once assumed these can achieve the status of fact rather then speculation.
Overconfidence	This describes the misplaced confidence that people have in their own abilities and judgments.
Confirmation bias	This describes a tendency for individuals or groups to search for information that supports an adopted or preferred position or interpretation of events and avoiding falsifying evidence. Additionally this bias describes the tendency to interpret information in a way that supports or confirms a desired position or preferred interpretation, thereby reducing cognitive dissonance.
Diagnosis bias	Once a conclusion such as a medical diagnosis has been reached, evidence or contrary arguments that are dissonant with that conclusion may tend to be underrated or disregarded.
Belief bias	The tendency to judge evidence or an argument on the basis of its fit with belief structures; dissonant evidence is likely to be rejected on the basis of belief rather than comprehensive analysis and reappraisal.
Congruence bias	This describes the tendency for individuals to directly test, rather than indirectly test, suppositions and more formal hypotheses relating to a problem to be solved or situation to be interpreted.
Future discounting	People will tend to regard short-term gains as preferable to even significantly larger gains at some point in the future. Significant future risks are also discounted; they are judged as disproportionately less significant than risks that may manifest in the short term.
Psychophysical Distortions	
Bias	Comments
Cognitive narrowing	This describes the behaviour of individuals in focusing on elements of a situation rather than the situation as a whole, and the level of narrowing may be progressive as a response to mounting levels of stress.

Framing	Framing is a form of description dependency in which the way in which information is presented, where the manner of presentation can influence its interpretation e.g. 5% fat *vs* 95% fat free.
Affect	This describes that way in which a person's emotional response to circumstances or information can influence decisions made about it. For example, a positive feeling (affect) about a situation has been shown to lead to a lower perception of risk and a higher perception of benefit.

Summary: What can crisis managers do about these biases?

The key point to understand is that they are natural and innate. They probably cannot be entirely suppressed and it is probably best not to try. However, knowing about them and understanding how they work can help decision-makers moderate their impact and question their thought processes. In general:

- Be aware of them and their potential influence.
- Make others aware of them in the team.
- Be reflexive, and critically review past actions and decisions to identify their influence.
- Get rapid and honest feedback on your choices.
- Use "neutrals" to test your choices (people with a different profile of biases).
- Encourage candour and openness in discussions, allowing all to speak and be listened to.
- Recognise that you can mitigate these biases, but not avoid them.

Leaders should, in particular:

- Be careful not to impose their "frame" on the group, especially when it reflects a single agency's or team's perspective or concerns.
- Hold back to avoid this and allow the team to work on solutions before intervening.
- Try to define problems in a variety of ways or from a variety of viewpoints, so that no one "frame" dominates through association with the leader.
- Surface, test and examine all assumptions made by all members and teams.
- Be aware of the anecdotal tendency of groups to have a collective threshold of acceptability in risk that is higher than would be the case with individuals.

Appendix C: a checklist of practical considerations in situational assessment

SUPPLEMENTARY QUESTIONS TO ASK ABOUT EVENTS AND IMPACTS:

Events – establish a rounded picture of events by asking:

- What? How? Where? When? Who? Why?
- Is there anything you would normally expect to see that is absent?

Baseline – a sense of context is critical:

- What does normal look like?
- Are denominators, metrics & measurements established and commonly understood?
- Are there any relevant trends?

Concurrence – is / has anything similar / related / significant happened:

- What else is happening?
- What else might happen at the same time?

Causes – build an awareness of causal factors:

- What is the immediately apparent (proximate) cause?
- Can the deeper underlying (root) causes be identified?
- Does this indicate other similar events might now be more likely?

Consequences / wider impacts – track direct, indirect and interdependent impacts:

- What will be the immediate consequences?
- What interdependent or systemic impacts might arise in the short and medium term?
- What might be the long-term impacts?
- If it is useful to disaggregate dimensions, consider PESTLE:

Explicitly articulate future scenarios and summarise associated assumptions and risks:

- Most favourable scenario, or the best case

- Reasonable worst case scenario
- Lower probability, higher impact scenario

SUPPLEMENTARY QUESTIONS TO ASK ABOUT EVIDENCE, ASSUMPTIONS, COMMUNICATIONS, PROCESS, AND CONCLUSIONS:

Assessment of data and information is critical:

- Of the basis for decision making what is a) known/solid b) unclear/caveated, c) presumed/unsupported by solid evidence?
- On what basis and to what degree is the source reliable?
- On what basis and to what degree is the information credible?
- Are the criteria for judgments established and commonly understood?
- Has the chain of evidence been checked, preferably by 3rd parties?
- Does evidence conflict with or corroborate that from other sources?
- Is there anomalous evidence that might support another interpretation?
- Is there any evidence that you might expect to see missing?
- What is unknown? What are the gaps in evidence or understanding?
- What steps are you taking to resolve uncertainties?

Misunderstood or differently understood **concepts and terminology** can impede shared situational awareness:

- Is terminology and scientific concepts commonly understood?
- Is any probabilistic language (e.g. likely) commonly understood?
- Are acronyms / abbreviations recorded and commonly understood?
- What other sources of ambiguity and confusion exist?

Assumptions - where relevant go through the following steps:

1. Find them – rigorously seek out the assumptions you are making
2. Explicitly describe them in plain English, using agreed terminology
3. Categorise them:

   a) Are they load bearing or marginal i.e. if they fail, how serious?
   b) Do they relate to the problem (e.g. risk) or to the solution (e.g. available capabilities)?
   c) How reliable are they – solid, caveated or unsupported?

4. Test them wherever possible – it is often hard to robustly test assumptions, but ask:

   a) Why are we confident that this assumption is correct?
   b) In what circumstances might this assumption fail?
   c) Could this assumption have been true in the past but not now?
   d) What consequences would the failure of this assumption have?

5. Share your understanding and keep assumptions under review.

Interpretations and conclusions – expose flaws in data, premises, logic and process:

- Is there an established consensus on the facts, their meaning, critical uncertainties and assumptions, and judgments and conclusions?
- Are there pressures operating in favour of a particular finding, interpretation or position?
- Can we apply tests to disconfirm assumptions, explanations and conclusions, or are we only using confirmatory approaches that support established positions?
- What evidence would be required to make our interpretations invalid and is it available?
- Was any evidence discounted as anomalous? What alternative explanations might it support?
- Are we under or over-estimating likelihood or significance of events?
- If working on the basis of small samples on what basis can we assume they are representative of whole population? i.e. are we distinguishing between signals and noise?
- Is baseline incidence or prior probability of an event adequately considered in assessing future likelihood?
- Are we giving a misleading impression by false precision (e.g. 23.968 instead of 20-25)?
- Framing - are evidence or conclusions presented in a way that can influence interpretation?

SUPPLEMENTARY QUESTIONS TO ASK BEFORE COMPLETING THE ANALYSIS AND CREATING OUTPUTS:

Conduct a pre-mortem, an approach that attempts to view current analysis as if in retrospect. Questions used look for problems, inconsistencies, biases, unsafe assumptions, wrong conclusions or other errors of evidence or reasoning:

- Was key evidence unreliable?
- Was there a common understanding of *What? So what? What might?* and *What if?*
- Was any contradictory evidence ignored?
- Is it possible we were misled by the absence of evidence?
- Might our key assumptions be invalid?
- Did we consider alternative explanations, cause-effect relationships or scenarios?
- Did external events or influences affect the outcome?

Appendix D: About The Authors

Dr Robert MacFarlane is Assistant Director (UK Resilience Doctrine and Training) in the Civil Contingencies Secretariat, Cabinet Office. Amongst other things he is responsible for support and assurance for all courses run by the Emergency Planning College and leads the programme of Central Government Emergency Response Training in the Cabinet Office Briefing Rooms (COBR). He has trained situation cell and crisis teams across government, from the Home Office to Department of Health and 10 Downing Street to the Joint Intelligence Organisation, and has trained a number of overseas governments on crisis management.

Rob was one of the principal authors of the JESIP Joint Emergency Services Doctrine and chairs the British Standards Institution technical committee with oversight of societal security, emergency and crisis management and resilience. He has attended the Strategic Leadership Programme for Security, Resilience, Defence and Intelligence at the UK Defence Academy and the US Leadership in Homeland Security Program at Harvard University. He has a first degree from the University of Leeds, an MSc and a PhD from the University of Aberdeen, and is currently studying part time, sponsored by the Cabinet Office, for a Doctorate in Business Administration at the University of Durham, focusing on decision support for strategic crisis management in COBR.

Mark Leigh joined the Cabinet Office Civil Contingencies Secretariat as Assistant Director of Training and Doctrine in 2005 after a career in the Army. He transferred to Serco as the Head of Faculty of Civil Protection in 2010. This very broad faculty includes more than forty programmes in all aspects of multi-agency emergency and crisis management, with a team of 30 lecturers and consultants. His particular interests are in risk and the sociology of crisis management, decision-making and organisational culture. His faculty includes all the college's strategic courses and is in academic partnership with the Portsmouth University.

He gained varied operational experience at the tactical and strategic levels in the intelligence, security and counter-terrorism fields in the UK, the Middle East and Southeast Asia. He also specialised in the training and development of leaders and managers in both the British Army and the Royal Brunei Armed Forces.

Mark is a qualified further education teacher and has four university degrees, including Politics, Sociology, an MSc in Training and HR Management and an MSc in Risk, Crisis and Disaster Management. He was the author of the first training programmes written for the UK national crisis management centre (COBR). He was the lead consultant on three national risk assessment projects for overseas partners and designed the training programme in critical infrastructure resilience management for one of the Gulf States. He has experience of leading strategic consultancy and training programmes and teams across the full range of civil protection fields in Jordan, Qatar, Bahrain, the UAE, Saudi Arabia and China – as well as extensively in the UK.

Robert MacFarlane and Mark Leigh have collaborated on one previous publication in the Emergency Planning College's Occasional Paper strand: **Leadership in Multi-Agency Co-ordinating Groups: A Functional Approach (2013)**.

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