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DECISION MAKING, TEAM MONITORING AND ORGANISATIONAL PERFORMANCE

Part two: decision making research stream

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Cover: NSW RFS leaders talking through their decisions during the January 2013 bushfires.

Photo by NSW RFS.

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DECISION MAKING RESEARCH STREAM OVERVIEW

This document forms Part two in a series of reports on decision making, team monitoring and organisational performance. It should be read in conjunction with:

- Decision making, team monitoring and organisational performance part one: executive summary
- Decision making, team monitoring and organisational performance part three: team performance monitoring research stream
- Decision making, team monitoring and organisational performance part four: organisational performance research stream.

All parts can be located at www.bnhcrc.com.au, under the **Practical decision tools for improved decision-making in complex, time constrained and multi-team environments** project page.

This research stream investigates strategic decision-making during emergency events. It has a specific focus on how coordination occurs at regional and state levels of emergency management (EM), although does not exclude the interactions between these levels and the IMT. The research will apply the following sequence:

1. To understand and interpret decision-making processes in emergency management in Australia and New Zealand (outlined in this report);

2. Identify opportunities to improve decision-making (outlined in this report) and,

3. To test heuristics (cognitive rules of thumb) and other strategies to improve decision making in controlled environments to assess their validity and reliability (future research activity).

To support these objectives, this section of the report is structured in the following way. First we examine the literature relevant to this specific 'class' of decisions made at Regional and State levels, noting that more than one type of decision-making process is applied. We then look at different decision models that are used in EM and critique them with respect to the literature. We then explore some of the limitations of these models and identify the opportunities for enhancement. Finally, we propose a strategy for the next stage of the research project. We suggest using a human-centred design process and an assessment of end-user organisation's maturity to appropriately tailor a tool to the organisation. Embedded within the design process will be the testing protocol to assess validity and reliability of the tool.

DECISION-MAKING IN EMERGENCY MANAGEMENT

In 2009 the Australian state of Victoria endured one of its most severe and prolonged heatwaves resulting in a number of catastrophic bushfires that resulted in the death of 173 people. The response to the bushfires was characterised by many people trying their best in extraordinarily difficult circumstances. There were many examples of people who met the challenge admirably. Nevertheless, some poor decisions were made by people in positions of responsibility. The Royal Commission is conscious of the pressure and difficulties people faced on the day, but it would be negligent if it overlooked the shortcomings: we need to learn the lessons so that problems can be avoided in the future. (Excerpt from the 2009 Victorian Bushfires Royal Commission)

Decision making in emergency management can be challenging and stressful due to the dynamism, complexity, uncertainty and temporality that occurs in this environment (Brehmer, 1987; Danielsson & Ohlsson, 1999). For the purpose of this paper, we use the term emergency management in the context of the decision makers from Australian emergency services (e.g. police, fire, SES[1]) that operate in the response phase of an incident. This context in which decision makers operate in emergency management is not unique and is comparable to other safety critical high consequence environments such as the military and health industry (Baker, Day, & Salas, 2006; Wildman, Fiore, Burke, & Salas, 2011). Decision makers in these three types of environments often use mental shortcuts or heuristics, to aid in the decision making process (Aberdeen, Thiébaux, & Zhang, 2004; Croskerry, 2002; Mishra, Allen, & Pearman, 2013).

Decision making in emergency management is a practical problem that can rapidly intensify when a situation quickly deteriorates as witnessed in the 2009 Australian Black Saturday Bushfires. Following these events and when poor decisions are formally examined as observed in the Victorian Bushfires Royal Commission, it is highlighted that decision makers are basically using a rational model. Being cognisant of this, agencies frequently embed rational decision making approaches in their operational doctrine and procedures. Nevertheless, under environmental constraints this is not typically how people make decisions in emergency management. Thus there is an obvious inconsistency how decision makers in this domain actually make decisions.

[1] The State Emergency Service (SES) is a predominantly volunteer organisation responsible for responding to flood and storm hazardous events.

A SHORT SUMMARY OF THE AFAC/BUSHFIRE CRC RESOURCE 'DECISION MAKING UNDER PRESSURE'

The literature on decision-making is vast, and a thorough examination of all facets of decision-making is neither possible nor desirable in this document. We also note that AFAC and the Bushfire CRC have been responsible for producing the IMT resource 'Decision Making under Pressure' (Hayes, 2014) and that this resource contains a comprehensive summary of decision-making for those interested to read further about this issue. A short *precis* of key points from that document are provided below:

- IMTs have to make decisions in wide ranging conditions, so various models and processes may be more applicable at different points of time – this is also true at Regional and State levels and for incidents at 'Level 3' or those considered 'out-of-scale'.
- Emergency events 'don't play by the rules'. All levels of the EM command structure have to make decisions in complex and demanding environments.
- The decision-making environment is dynamic – a series of decisions are required to achieve a goal; the decisions required are not independent; earlier decisions tend to constrain later decisions. The state of the environment continues to change, and decisions need to be made in real time (Brehmer, 1992).
- The decision-making environment is uncertain. The timing, accuracy and completeness of the available information is far from certain and the complexity of combining discrete sources of information is high.
- Decision-making is constrained by a range of contextual factors – organisational, political, social and financial/resource-driven.
- The decision maker often doesn't have the privilege of making 'obvious' decisions, or rather the decision does not often reveal a 'best' or 'optimal' solution. This is partly because of tensions around issues such as risk, temporal issues (short term versus long term), efficiency versus thoroughness and logical process versus intuitive or gut-instinct approaches (Omodei, 2012).
- Routine problem-solving or decision-making tends to occur in more automatic ways, and the approach to automatizing behaviour is usually to develop an associated skill. Think about the automatic way you decide to change gears in a manual car, for example. As the decision context becomes more novel it requires the decision-maker to process information more consciously, either using rule-based approaches, or if no rules apply, making the decision using the underpinning knowledge available to them (Rasmussen, 1983). The more novel the problem, the greater the strain on the cognitive resources of the decision-maker.
- Decision-making is undermined by a range of factors including fatigue, stress and errors due to the nature of the cognition.
- Decision-making comes in different 'styles' – Flin (2008) indicates there are four – creative, analytical, procedural and intuitive. In practice these are decisions that differ in terms of the amount of conscious effort required and the strategies applied can also vary. At different phases of an emergency some or all may be necessary.

DECISION MAKING IN OTHER SAFETY CRITICAL DOMAINS

We turn now to focus on the issue of negotiating the switch between these different styles of decision-making. Our particular focus is on how the decision-maker shifts between what has been referred to as 'Type 1' decision-making (automatic, heuristic, intuitive) and 'Type 2' (conscious, analytical, reasoning and reflective). We characterise the problem not as should we use one or the other, but how do we support the decision-maker to find the balance, to recognise the shift, and to see the merits of both types of decision-making. Examining what decision making theories (Figure 1) are used in other safety critical high consequence environments may enable decision makers in emergency management to adopt different perspectives when making decisions in high consequence situations.

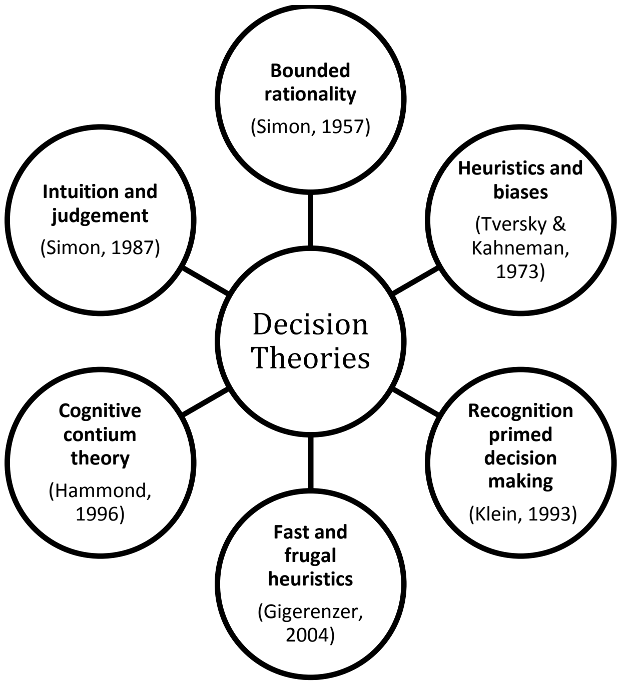


Figure 1 Decision making theories relevant to this paper

The progression of decision making theory has emphasised the interactive dynamics of working situations. The characteristic of Classical Decision Making (Savage, 1954; Von Neumann & Morgenstern, 1944) was primarily concerned with the logical consistency of the decision process (Bordley, 2001) and the selection of a 'correct' outcome given that process. Undermining the descriptive validity of the classical model was Behavioural Decision Theory (Edwards, 1954) that showed how people tend to deviate systematically from a rational choice model (Kahneman & Tversky, 2000; Tversky & Kahneman, 1981; Tversky, Sattath, & Slovic, 1988). Following on from this in the 1950's was the theory of Organisational Decision Making. This began with the seminal works of Simon (1957) who applied the concept of 'bounded rationality'. He demonstrated that decision makers deviations from the rational choice model make sense if the cognitive apparatus is considered as a limited (bounded) attentional system continually striving to minimize the information processing load caused by decision making (Simon, 1957). Behavioural Decision Theory retained a formality in modelling, yet also undermined the descriptive validity of the classical model by showing how people tend to deviate systematically from a rational choice model (Kahneman & Tversky, 2000; Tversky & Kahneman, 1981; Tversky et al., 1988). This work included empirical evidence of heuristics or (intuitive decision strategies) that described how people applied them to reduce their cognitive load.

Naturalistic Decision Making is differentiated from these other perspectives of decision making research by a number of factors. These include the study of dynamic environments, ill-structured problems, focusing on experts rather than novices, accounting for time stress, action feedback loops, competing goals and organisational goals/norms (Orasanu & Connolly, 1993). Naturalistic Decision Making has recognised that expertise has a degree of context specificity (Ericsson & Lehmann, 1996) and also that decision makers monitor for both the structure and order of information as well as the information's meaning (Wagenaar, Keren, & Lichtenstein, 1988). Associated, but certainly not appurtenant to the theory of Naturalistic Decision Making, is the body of research that recognises the benefits of both intuitive and analytical modes of judgement in decision making while acknowledging the limitations of both. This led to the notion of quasi-rationality (Brunswik, 1944) and dual process theory. We will first examine organisational decision making theories that have been adopted in a number of safety critical high consequence environments.

Ever since Simon (1957) argued that due to human's cognitive limitations, we generally have little option but to construct simplified models of the world, researchers have proposed simple decision making strategies. Heuristics are a product of these simplified models that allow humans to cope with their limited information processing capacity and provide shortcuts that can produce decisions efficiently and effectively (Shanteau, 1989). Tversky and Kahneman (1973) stated that when people make predictions and judgments under uncertainty, they do not appear to follow the calculus of chance or the statistical theory of prediction. In these times of uncertainty they instead rely on a limited number of heuristics which sometimes yield reasonable judgments and sometimes can lead to severe and systematic errors (Kahneman & Tversky, 1972; Tversky & Kahneman, 1973). Research conducted in the field of heuristics and biases suggest that algorithms significantly outperform humans under two quite different conditions. The first is when validity is so low that human difficulties in detecting weak regularities and in maintaining consistency of judgment are critical. The second is when validity is very high, in highly predictable environments, where ceiling effects are encountered and occasional lapses of attention can cause humans to fail (Kahneman & Klein, 2009).

The domains of emergency management and health have identified that decision makers often have a reliance on previous experience and thus intuition (Halter et al., 2011; Kowalski-Trakofler, Vaught, & Scharf, 2003). Nevertheless, intuition can also be considered a source of bias and potentially lead to mistakes (Croskerry, 2002; Eva, Link, Lutfey, & McKinlay, 2010). In the healthcare industry there is a movement that believe physicians should be trained in aspects of cognitive psychology. Learning how to use de-biasing strategies and thus ascribing to an alternate logical or rational model of decision making, may assist in reducing the risk of diagnostic error (Almashat, Ayotte, Edelstein, & Margrett, 2008; Lucchiari & Pravettoni, 2012; Stiegler, Neelankavil, Canales, & Dhillon, 2012). The determination of whether intuitive judgments can be trusted requires an examination of the environment in which the judgment is made and of the opportunity that the decision maker has had to learn the regularities of that environment. Environments that have stable relationships between objectively identifiable cues and subsequent events or between cues and the outcomes of possible actions can be described as 'high-validity' as found in health care and fire fighting (Kahneman & Klein, 2009). There is a body of researchers that adamantly reject the focus of biases in the heuristics and biases approach and are also deeply sceptical about the value of using rigid algorithms to replace human judgement (Kahneman, 2011). These researchers belong to a community who study naturalistic decision making (Cannon-Bowers & Salas, 1998; Collyer & Malecki, 1998; Klein, 1998; Woods, O'Brien, & Hanes, 1987).

A focus of the naturalistic decision making approach is on the success of expert intuition. Early research conducted in the domain of fire-fighting discovered that personnel could draw on a repertoire of patterns they had gained from previous experience and took advantage of their existing knowledge (Klein, Calderwood, & Clinton-Cirocco, 1986). Klein (1993) proposed a model focused on rapid decision making called the recognition primed decision model. This was based on data collected from urban fire-fighting commanders about events they had recently responded to (Klein, 1993). The fire-fighting commanders attempted to recognize and appropriately classify a situation. Once they had made a classification, they knew a typical way to react to it. If complex enough, they might follow a virtual causal sequence of events, to discover if anything might go wrong. If problems arose, the option might be modified or rejected outright. This is highlighted by an example of a fire commander during the response to a fire in a basement of a four storey apartment building. Upon arrival the fire commander assessed the problem as a relatively straight forward incident of a fire in a laundry chute. However, the fire was actually at an advanced stage that was not immediately visible to the fire crews. The fire commander used their experience to generate a workable option in the first instance. When conditions worsened the option was initially modified but when the conditions worsened still the initial option was rejected altogether, and another highly typical reaction was explored (Klein, 1993). The concept of recognition primed decision making has been applied in other high validity environments including the health industry (Farmer & Higginson, 2006; Flin, Youngson, & Yule, 2007; Pauley, Flin, Yule, & Youngson, 2011), the military (Kaempf, Klein, Thordsen, & Wolf, 1996; Serfaty, Macmillan, Entin, & Entin, 1997), and finally within emergency management and particularly with fire agencies (Fasolo, McClelland, & Todd, 2007; Klein et al., 1986; McLennan, Holgate, Omodei, & Wearing, 2006). Nevertheless, research also conducted in these environments has also investigated the applicability of heuristics for rapid decision making.

One type of rapid decision making strategy is fast and frugal heuristics (Gigerenzer, 2004). Fast and frugal heuristics are founded on the probabilistic mental model theoretical framework and belong to a wider type of heuristic known as lexicographic heuristics (Gigerenzer & Goldstein, 1996). Fast and frugal heuristics are a type of cognitive heuristic that rely on a few relevant predictors in an effort to simplify and speed up the decision making process (Gigerenzer, 2004). Decision makers follow a series of sequential steps prior to reaching a decision. Fast and frugal heuristics are built around three rules; one that specifies in what direction information search extends in the search space (search rule); one that specifies when information search is stopped (stopping rule), and one that specifies how the final decision is made (decision rule) (Marewski & Gigerenzer, 2012). The concept of fast and frugal heuristics is particularly evident in the health industry across a number of disciplines, including nursing (Cioffi, 1997; Thompson, 2003), midwifery (Muoni, 2012), paramedical science (Cook, 2001) and medicine (Pieterse & de Vries, 2013; Wegwarth, Gaissmaier, & Gigerenzer, 2009).

In medicine, physicians often make diagnostic decisions using a type of fast and frugal heuristic' and this is predominantly visible in critical care environments such as found in anaesthetics and emergency medicine where rapid decision making is required (Gigerenzer & Gaissmaier, 2011; Stiegler et al., 2012). Evidence of fast and frugal heuristic' is also evident in the military. The principles of Major Incident Medical Management & Support delivers a simple heuristic based on yes and no answers that is used for managing the scene of an incident resulting in mass casualties in a military environment. This benefits the casualty by ensuring scarce resources are effectively managed, reducing the risk of a poor response and doing the most for the most. In dynamic and uncertain environments such as critical care medicine, the military and emergency management, fast and frugal heuristics can enable decision makers to make certain decisions quickly by the way the information is structured and its appropriateness under the conditions where it is applied (Katsikopoulos, 2011; Todd & Gigerenzer, 2000). However, in certain situations that require decision making in dynamic, uncertain and complex environments such as the aforementioned domains, there is a higher likelihood that the decision maker will search for additional information and draw on previous experiences (Dhami & Harries, 2001). When heuristics succeed in this context they are deemed economical, resourceful and effective, but when they fail they, they are often referred to as cognitive biases that contribute significantly to poor decisions (Croskerry, 2002; Stiegler et al., 2012).
As previously considered, heuristics have had proven success in some safety critical high consequence environments. In spite of this, some researchers have acknowledged that decision making is a combination of not only the 'Type 2' processing as identified in the retrieval of highly diagnostic cues that are evident in recognition primed decision making, but also 'Type 1' processes associated with heuristics. This combination of 'Type 1' and 'Type 2' processes led to the development of dual process theories of cognition that can be identified in decision making in a number of high consequence environments (see for e.g. Barbey & Sloman, 2007; Evans, 2008; Kahneman & Frederick, 2002; Stanovich, West, & Toplak, 2011; Stanovich & West, 2007).

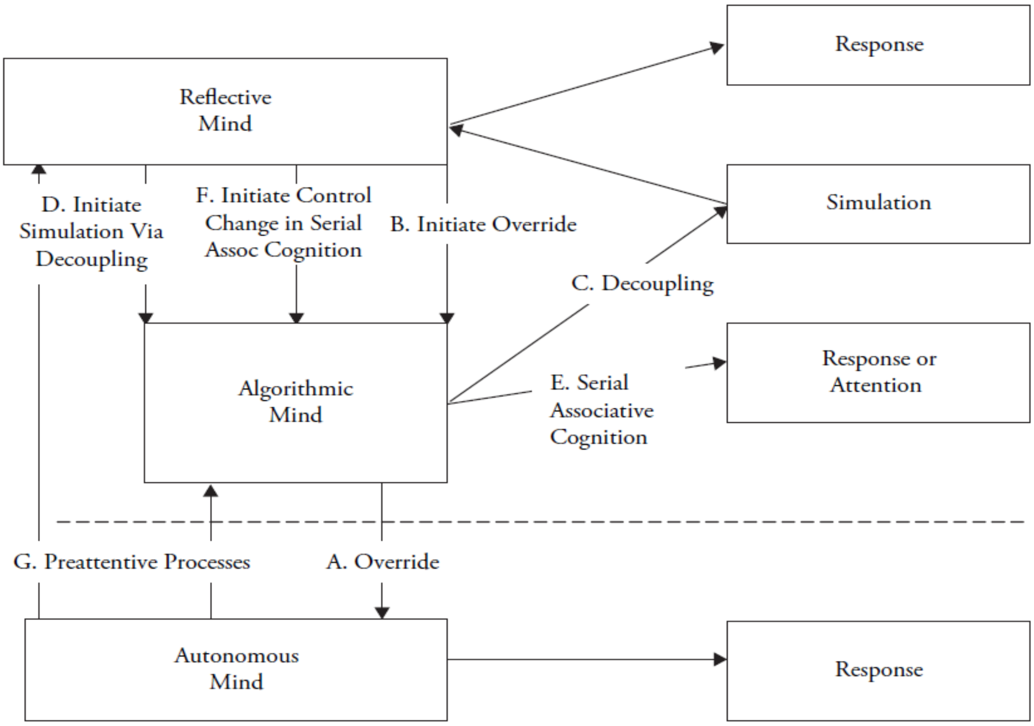


Figure 2: Stanovich's Tripartite Structure of the Mind

Drawing on the theory of dual processes is a deceptively complex endeavour due to drawing of misleading predictions (Stanovich et al., 2011). This can be addressed by understanding how likely decision makers are to override a pre-potent response that is incorrect and to engage in further reflection that leads to a more suitable decision (Toplak, West, & Stanovich, 2014) as identified in the figure above. This figure identifies a 'tripartite' rather than a dual-process (from the autonomous to the algorithmic to the reflective mind) with a key issue being the decision-makers ability to recognise the circumstances in which they need to override 'lower' processes and engage more mental resources to make the decision. An alternative theory that could really be seen as extending this concept within this discipline posits that modes of cognition lie on a continuum and include a variable combination of both intuition and analysis in decision making (Hammond, 1996, 2000).

Cognitive Continuum Theory (Hammond, 1996, 2000) emphasizes the combination of finding the idle ground between intuitive and analytical thought processes in decision making. The concept of how modes of cognition lie on a continuum has recently gained popularity in some safety critical high consequence environments. In the health industry, research suggests that most clinical problems are solved involving hunches that need to be checked, partial solutions, possibilities that need to be ruled out, and implicit or explicit heuristics, all in the face of uncertainty that cannot be reduced (Custers, 2013; Fedo, 2014). In a military context the circumstances surrounding decision making using unmanned aerial vehicles or 'drones' are typically complex. Novel and unfamiliar scenarios encourage analytic thought because there is not a wealth of experience to draw upon. New problems are being faced with no established solutions; for example, the ethical and legal questions that are being raised along with questions about how to make best tactical use of the new capabilities. Drawing upon previous experiences with manned operations can be problematic if they are not appropriate, leading to biased judgments. Therefore decision making is characterized by a mixture of intuitive and analytic thought processes (Banks & Dhami, 2014). Correspondingly, contemporary research conducted in the emergency management environment examined decision makers who were the coordinators of an incident response and were required to make tactical decisions in a complex, uncertain and time constrained environment. This research provided strong corroborating evidence that these tactical commanders do not consistently use 'Type 2' decision processing, but employ significant amounts of 'Type 1' within an overall approach that employs both (Mishra et al., 2013).

Thirty years since Simon (1957) suggested that cognitive limitations require humans to construct simplified models of the world, it would appear that due to the increased complexities of modern societies, decision makers, depending on their particular situation, may have to employ a combination of intuition and analysis in their decision making process (Simon, 1987). It is important to understand what processes of decision making may potentially be utilised and best suited in emergency management. In order to understand how this might work, the first stage of this project has been to examine approaches to decision-making within Emergency Management in Australia and New Zealand. The models presented below are representative of different approaches rather than a complete set of models used across the industry.

METHOD/INDUSTRY ENGAGEMENT (WHERE, HOW, WHO)

The aim of this first phase of the research was to deeply understand the approach taken within the participating end-user organisations around the issue of decision-making, and particularly for decision making in what some people describe as 'out-of-scale' events, or in situations where the obvious/standard processes were difficult to apply. With this in mind, we used a research method that was strongly qualitative – focusing on in-depth semi-structured interviews and observation. The process included seeking answers to the following questions:

- Understanding the structure of the end-user organisation.
- Understanding any nuances in the implementation of AIIMS functions.
- Assessment of agency documentation on the implementation of decision-making strategies within documents such as SOPs or training documentation.
- Conducting semi-structured interviews with Level 3 Incident Controllers and Senior staff to explore decision-making approaches (30+ interviews conducted) in NSW SES, CFA, MFB, TFS, QFES.
- Observing simulation events (Operation Headache – QFES) and actual events (G20 – Brisbane).
- Participating in a staff ride in Tasmania, running a focus group in TAS SES.
- Assessment of current literature around decision-making

CURRENT PRACTICE – DECISION MAKING AS PART OF A SYSTEM

It is important to recognise that the system for managing decisions is much larger than just a decision-making tool – such as a rule of thumb, a decision-model or an aide memoir. The doctrine, policies, procedures and other organisational systems that wrap around the decision-maker all influence, and are therefore all part of the decision-making process. For example, in QFES the development of an Incident Action Plan is informed by the available Incident Action Guide (which focuses on pre-planning for tactical response and recovery). There are also a number (currently 14) operational guides. These policies support the procedures associated with the development of the IAP which has embedded in it a decision-making process of sorts because in order to identify actions, one must collect information and decide on the state of the event (orientation). Therefore decision-making within this context could be seen as an interaction between many different components, and it is important to understand that this interaction exists and to look at where, in any individual organisation, opportunities might exist for improvement. The diagram below attempts to identify these components and interpret at a very coarse level the relationship between them. It suggests that a group of elements impinge on decision-making at the IMT level – broader doctrine, operational guides, IAP processes, risk assessments and heuristics. Everything is underpinned by the decision-making model and the recording approach cuts through all of this to influence outcomes.

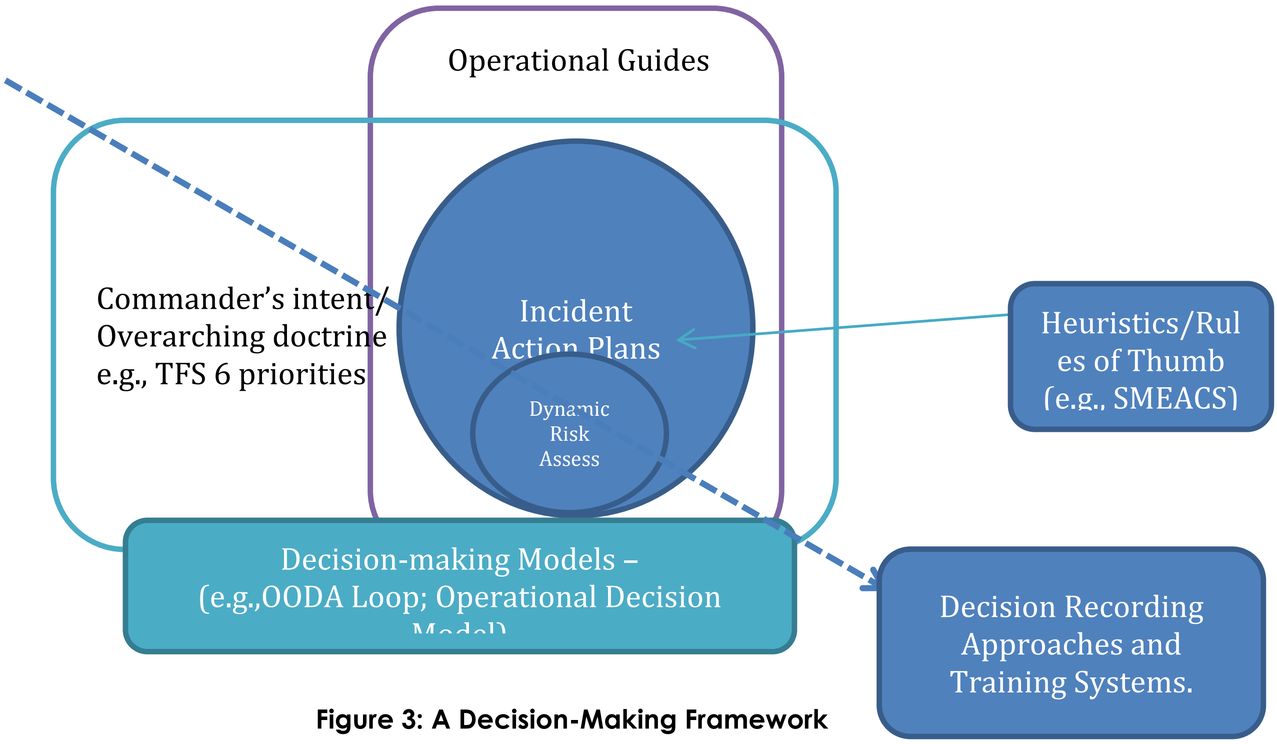


Figure 3: A Decision-Making Framework

What follows are exemplars of different elements of these components of the emergency management decision-making framework described above.

TFS Operational Priorities These priorities are identified as being applied when bushfires are burning out of control.

Warn the community – Gather, analyse and disseminate information on current and predicted fire location, direction and rate of spread, and issue timely warnings to those threatened by fire.

Protect vulnerable people – Protect vulnerable civilians who may be gathered in schools, nursing homes, community shelters and the like. This necessitates the identification and assessment before the fire season of sites in the community likely to be housing or sheltering vulnerable people, and the assignment of crews to focus on the protection of these sites and their occupants if fires threaten.

Protect key community assets – protect key vulnerable community assets that have been identified as such by the community. These may include flagship industries or businesses upon which the community relies for its very existence, as well as shopping centres, schools, hospitals, power facilities, churches, historic buildings, the local pub and the like. Protecting these will improve community resilience by enabling communities to recover more quickly from bushfires. It necessitates the identification of assets that particular community's value, mitigation of their vulnerability, and the assignment of crews to protect them when fires threaten.

Stop the spread of fire in built–up areas – Stop the spread of fire in built-up areas through building-to-building ignitions. Options to enable to be done rapidly should be explored so that resources are not tied up for extended periods at individual homes or buildings. The protection of homes in build-up areas should result in fewer losses than seeking to protect the same number of homes scattered over the landscape, and therefore should be a higher priority for firefighters.

Protect other community assets – Applying TFSs triage policy, defend homes defendable by firefighters, particularly in areas of moderate to high housing density, where firefighting resources can move relatively quickly between homes and other assets under threat. Firefighters should not defend homes that cannot be defended safely, or homes that can be defended safely by civilians who are present.

Fight the fire – This should be the lowest operational priority for fires burning under severe to catastrophic conditions. On severe to catastrophic days, fires extinguished in the bush are likely to reignite, and any efforts to extinguish them are likely to be fruitless. People and highly valued assets should be protected consistent with priorities 2 – 5 above. Only when conditions have moderated should attention turn to containing and extinguishing the fire.

Interpretation

Indications from fire-ground commanders at the Dunalley/Inala Road Fire were that the six priorities allowed these decision-makers to triage their activities in the face of an out-of-control fire. The six priorities are essentially a decision tool (or a rule-of-thumb/heuristic) that allows for evaluation of how strategies and the fire itself are progressing and therefore might also be aid to have some relation to an overall 'command intent', adjusted for dynamically changing levels of control. It is also evident that the six priorities themselves are not completely sequential – TFS will continue to "Gather, analyse and disseminate information on current and predicted fire location" throughout a fire event.

Decision Recording Systems/Tools

INCIDENT CONTROL	CRITICAL DECISION LOG			
	INCIDENT:		TIME:	DATE:
	LOCATON:			
SECTION	INCIDENT CONTROL ☐ OPERATIONS ☐ PLANNING ☐ LOGISTICS ☐ DIVISION COMMAND ☐ SECTOR COMMAND ☐			
DECISION MAKER NAME		SIGNATURE		

ISSUE/EVENT *(The current issue or occurrence which has led to the need for a critical decision)*
DECISION *(Details of actions to be taken)*
REASON FOR THE DECISION *(Why the decision has been made)*
CONSULTATION *(Who has been consulted)*
BRIEFING *(Who has to be briefed)*

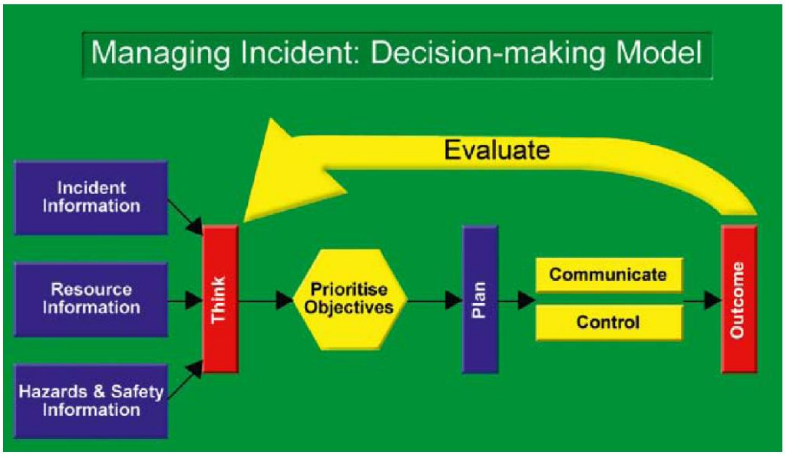
OFFICER MAKING ENTRY:		ENTERED TO:	
POSITION:		POSITION:	
TIME:	DATE:	TIME:	DATE:

Decision logs record ***decisions*** that affect the course of an incident and the ***rationale*** for those decisions based on an evaluation of the circumstances of the Incident as they were known at the time that the decision was made. The rationale of the log is identified below:

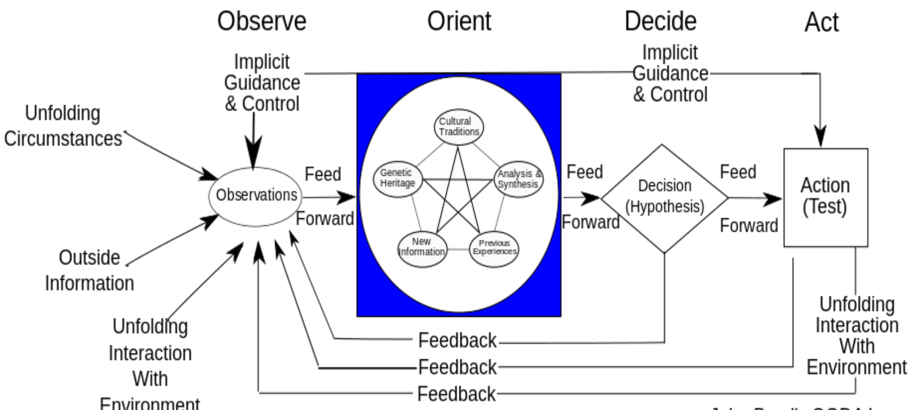
The log is intended to be the personal record of the Incident Controller or Operations Officer. Recording the rationale behind decisions at the time they were made can explain why they were correct in the circumstances and on the basis of the information existing at the time, and without the benefit of hindsight. This will be helpful in explaining to third parties that a logical decision making process was followed, and why decisions were changed in the light of developing information and events. Decisions may be challenged several years after they were taken, for example during legal proceedings. Such challenges can be difficult to defend without contemporaneous records of the reasons behind the decisions. It also provides accountability and transparency in justifying decisions, including those about resourcing of relative priorities, and of task allocation between investigators.

Interpretation:
Previous research suggests that formalising decisions will 'anchor' the decision-maker to that decision making it harder for them to change the decision in the face of contradictory evidence. This is especially the case in EM and command/control events where strong leadership is important. So if we accept that the log is necessary for record keeping, auditing, and legal purposes then it is important to recognise the issues that impinge on these decisions that are dynamic, uncertain, resource and time constrained. Any of these elements could be embedded in tools used to record those decisions.
Logs such as these could also provide prompts/aide memoir for known errors or thinking traps to support decision makers, and, given incident commanders at strategic levels make many decisions, some interaction between individual logs/decision recording approaches may be useful.

Models of EM Decision -Making
Many EM organisations have operationalised decision-making models although these tend to be operationalised at or below the IMT and therefore the application of these models at strategic (Regional and State) levels of coordination remains somewhat untested.



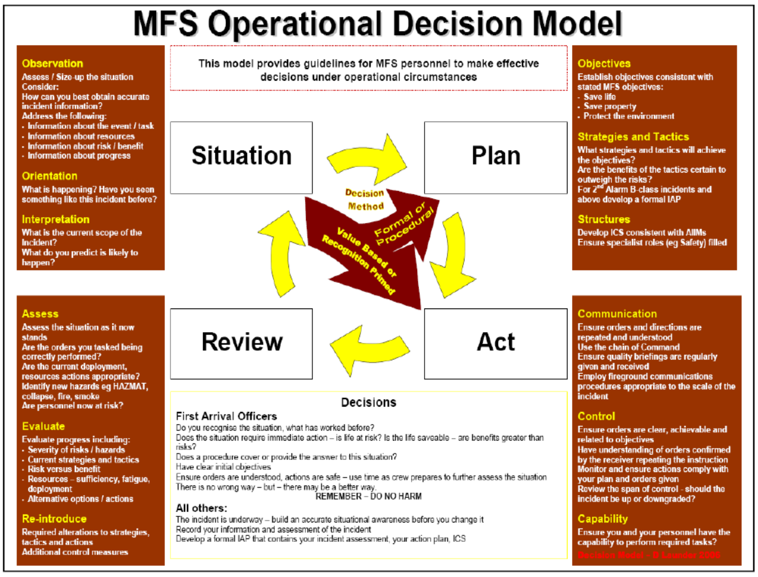
The London Fire Brigade Decision-Making Model uses a simplified approach to decision-making that is partially derived from research associated with building and maintaining situational awareness. In essence it requires the decision-maker to collect and interpret information, make a plan and then communicate and control an outcome. Importantly the model never asks the decision maker to 'decide' but creates a loop of constant evaluation. This aligns the decision-making process more with a philosophy of making 'sense' rather than making decisions.



John Boyd's OODA Loop

The OODA Loop: has been applied in some Australian EM agencies at operational levels. The phrase OODA loop refers to the decision cycle of Observe, Orient, Decide, and Act, developed by military strategist and USAF Colonel John Boyd. Boyd applied the concept to the combat operations process. Boyd's diagram shows that all decisions are based on observations of the evolving situation tempered with implicit filtering of the problem being addressed. These observations are the raw information on which decisions and actions are based. The observed information must be processed to orient it for further making a decision.

As stated by Boyd and shown in the "Orient" box, there is much filtering of the information through our culture, genetics, ability to analyse and synthesize, and previous experience. Since the OODA Loop was designed to describe a single decision maker, the situation is usually much worse than shown as most business and technical decisions have a team of people observing and orienting, each bringing their own cultural traditions, genetics, experience and other information.



MFS Operational Decision Model: This model includes elements similar to the two models above. In the Assessment of a situation you acquire information and observe to create an orientation. The decision-maker uses that information along with strategies, structures and objectives to plan, takes appropriate action and reviews the approach within a cycle.

Interpretation:

These types of models have generally acknowledged the issues associated with the likelihood that decision-makers will use intuition, rules and rational judgement to make decisions, that the decision-making process is dynamic and as such, that they will continually observe, orient, decide and act as per the OODA loop, also consistent with Klein's recognition-primed decision making model. The integration of value-driven decision-making recognises the need to protect property, life and the environment.

The model itself attempts to integrate many different concepts and as a result seems to be relatively complicated to actually use. For example, how does the First Arrival Officer manage the interaction between an OODA/recognition-primed process and one that is value-driven? The effort to integrate state-of-the art decision-making knowledge is commendable, but is usable?

Dynamic Risk Assessment Approaches

The definition of a dynamic risk assessment is: "The continuous process of identifying hazards, assessing risk, taking action to eliminate or reduce risk, monitoring and reviewing, in the rapidly changing circumstances of an operational incident" (ACT Government, 2012). This principle has been enacted within IAPs and as discussed earlier can therefore be considered to embed a decision-making process within the assessment.

During the dynamic (rapidly changing) phase, the decision making process involves analysing and reviewing the risks and benefits presented by the incident, selecting an appropriate response (system of work) and making a judgement on whether the risks are proportional to the benefits.

Although the dynamic management of risk is continuous throughout the incident, the focus of operational activity will change as the incident evolves. It is, therefore, useful to consider the process during three separate stages of an incident. These are;

1. The Initial Stage
2. The Development Stage
3. The Closing Stage.

Initial Stage of Incident There are 6 steps to the initial assessment of risk: 1. Evaluate the situation, tasks and persons at risk 2. Introduce and declare tactical mode 3. Select safe systems of work 4. Assess the chosen systems of work 5. Introduce additional control measures 6. Re-assess systems of work and additional control measures.

Development Stage of Incident

If an incident develops to the extent that the span of control is exceeded or if sectors are designated, the Incident Controller may delegate incident control roles. This may include the appointment of an operations officer or sector/ divisional command responsibilities. As the incident develops, changing circumstances may make the original course of action inappropriate, for example: Fire fighting tactics may change from defensive to offensive or New hazards and their associated risks may arise,

The decision-maker/risk assessor needs to manage safety by constantly monitoring the situation and reviewing the effectiveness of existing control measures.

The Closing Stage of the Incident. The three key activities involved in the closing stages of an incident are: Maintaining control; Welfare, and Incident Debrief.

This is based on Clancy's model of Dynamic Risk Assessment known as the 'Safe Person Approach to Dynamic Risk Assessment (Clancy, 2008).

Interpretation:

Risk Assessment is a structured and highly rational approach to decision-making if it requires the user to develop measures of the risk (probability × severity) for each risk present. However, if dynamic assessment the process is more simple and essentially a binary expert assessment (risk is acceptable or unacceptable based on current controls and changes in the state of the incident/emergence of new hazards, then this makes an effort to combine the intuitive judgement of the officer with a systematic approach for the management of the risks. Under these circumstances the office identifies controls, implement safe system of work and continually re-assess controls/system of work. There is limited peer-reviewed evidence to determine if this approach is more or less effective than any other approach. Studies that have assessed dynamic risk assessment have been in non-EM applications such as process engineering and assessment of sexual offenders, so that transferability of those studies to emergency management is unlikely. Many EM agencies have, however, embraced DRA, and if applied as described above (iterative binary approach) then it has potential to be an effective 'heuristic' (rule of thumb). It is to these types of rules that we now turn.

Heuristics or Rules-of -Thumb

There are a range of heuristics used within emergency management that assist in some way with the process of making decisions. A selection of these are identified below:

To help decision makers with this assessment the UK Fire Service Inspectorate has provided the following heuristic.

'In a highly calculated way, firefighters will:

- Take some risk to save saveable lives.
- Take some risk to save saveable property.
- Refrain from taking any risk at all to try to save lives or properties that are already lost' (HM Government, 2008; p. 65).

SMEACS

A simple SOP used in emergency management to ensure that thorough briefings are provided is described by the acronym SMEACS. This acronym reminds personnel of the six components of information that should be communicated in briefings, namely, Situation, Mission, Execution, Administration, Command, and Safety.

TOSSARS

A further example of a decision aid used by a land management agency is NSW National Parks and Wildlife Service's (NPWS) acronym TOSSARS. This acronym was developed by NPWS to especially help personnel newer to incident management prioritise the order in which they tackled an incident. Sometimes less experienced incident management personnel are not quite sure where to start managing an incident; TOSSARS helps solve this by providing an acronym summarising the recommended order in which IMT personnel should tackle an incident.
T-Threats (identify); O-Objectives (Set); S-Strategies (decide on); S-Sectorise (identify) AR-Allocate Resources; S-Safety (assess, identify, advise) (Hayes, 2014).

Interpretation:

The use of heuristics has been identified in the literature review of this report as having somewhat contested value. On the one hand they can be effectively used as a memory aid to support decision-makers, and have been shown to be effective in 'fast and frugal' environments. On the other hand heuristics are subject to a range of cognitive biases and can be applied to decision problems that they weren't designed for.

On balance, we would suggest that heuristics have definite value embedded within a broader decision-making framework that acknowledges the circumstances under which they can and may not add value to the decision-making process.

EMERGING ISSUES AND IMPLICATIONS

A number of issues have emerged from the investigations conducted in this phase of the research. These issues are associated with an interpretation of EM decision-making as a framework rather than considering decision tools in isolation. We see that there are opportunities to:

- Opportunities appear to exist to support improvement in Agency decision-making within the 'framework'.
- A lack of role clarity at strategic levels is a confounding issue in developing these improvements.
- The development of tools is likely to need to be supported by training systems.
- A slightly more radical interpretation of the issue would include a research program to enhance skills associated with issues such as divergent thinking and peripheral vision.

FINDING IMPROVEMENTS IN THE DECISION-MAKING FRAMEWORK

A key issue with respect to strategic decision-making (regional, state) in large scale emergencies is the disconnect between the way people actually make decisions in uncertain, time and resource constrained environments and the 'classical' approach to decision-making. The forensic post-incident examination of decisions tends to assume a classical approach, and even some decision-making tools assume that this is possible and more desirable than using intuition and heuristic approaches. Part of the problem has been to identify this as a duality – either the decision-making was rational or 'non-rational' however this is not a reasonable way to think about these different approaches.

The opportunities for improvement in decision-making exist in a number of areas. The first is in managing the bias embedded in human cognition. Omodei (2012) has referred to these as 'bias and error traps' and seen them as relating to three major areas:

1. Biases in thinking about the external situation.
2. Biases in thinking about oneself and others.
3. Biases in managing complexity and uncertainty.

De-biasing approaches include naming up these biases in aides-memoir and embedding them in decision-making models to specifically ask the decision-maker to reflect on those biases. More rational and conscious approaches to decision-making ask the decision-maker to consciously assess the possibility that bias has been embedded in the decision. Sometimes this is enough to adjust for the bias.

A second opportunity exists in developing an understanding of where, when and how decision-makers in emergency management should ***shift between the different approaches/styles of decision-making*** and what the implications might be. This would need to include the development of training approaches that improve the skills and knowledge of decision-makers at this level.

More Role clarity

The operational doctrine within EM Agencies identifying the specific role descriptions for personnel working at a strategic level is variable. Although there is clarity of roles at the incident management level this can be absent or ambiguous at regional and state levels, although we note several agencies are addressing this issue. As one participant noted:

"At a regional and state level we haven't invested enough into what is required of the people (working in this environment) and their competencies like we have done at our incident management level."

Subsequently it is problematic for personnel who are expected to make a decision at a strategic level when there is no role processes and therefore limited guidance on the expected decision making requirements of the individual. While we note that many Agencies are in the process of improving role clarity at strategic levels, it is possible to argue that until this issue is resolved it makes the process of supporting decision-makers more difficult.

BETTER TRAINING SYSTEMS IN DECISION-MAKING

When there is an identified lack of formalised operational doctrine targeting processes at a regional and state level the decision making capability of personnel working at a strategic level remains limited. A lack in training and in conjunction with that can improve performance, the majority of training for deployment to regional and state operations is reliant on exercising. Hoverer, there is often no component in strategic level exercises that specifically targets decision making. The majority of training for decision makers at this level is based upon guidance and mentorship from fellow colleagues with no formal arrangements documented:

"Formally there are no processes in place (for assisting decision making)...people have individual mentors, (and) depending on their role, offer guidance."

A recurring theme in the interviews suggested that given limited investment by some Agencies in decision making processes, executive managers should not complain when sub-optimal decisions are made:

"We don't have the same investment in our decision makers as the military have in their decision makers…there's not a lot of attention to detail for our strategic roles that can be found in other industries."

It is noteworthy that several participants mentioned that in the policy, research and Organisational Development section of the Agencies, models of evidence driven decision making to policy do exist. Examples include the *Using Knowledge to enhance decision making and improve performance* which is based upon the *Cynefin* model developed by David Snowdon. This model has been also been adopted in other industries in operational context (e.g., land-based safety management systems). One participant suggested that this model could be adopted by operational and corporate entities of the agency to aid in decision making.

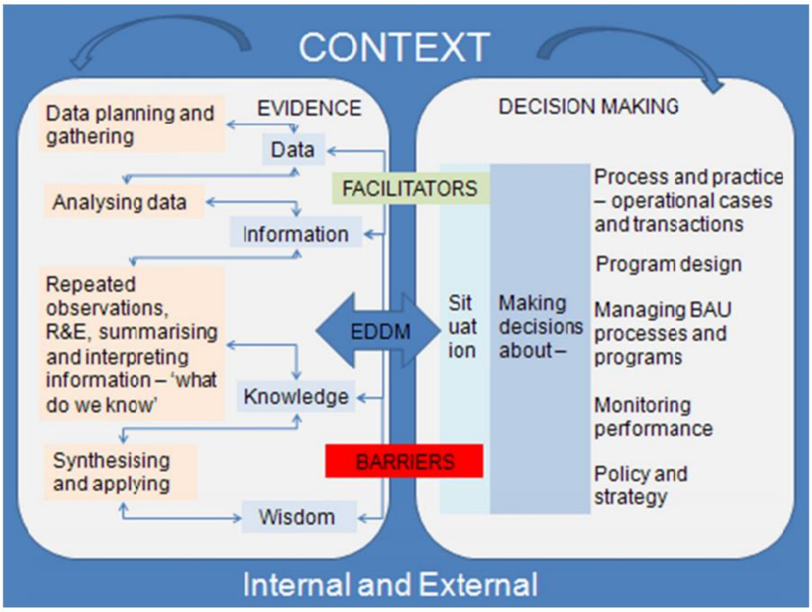


Figure 4: Elements of CFA's Knowledge Strategy

SUPPORT AND DEVELOP THE SKILLS THAT UNDERPIN DECISION-MAKING STYLES

As mentioned earlier, Flin (2008) indicates there are four decision-making styles – creative, analytical, procedural and intuitive. In practice these are decisions that differ in terms of the amount of conscious effort required and the strategies applied can also vary. At different phases of an emergency some or all may be necessary, although it is not clear in previous research the extent to which the styles creative and intuitive are used, particularly at the strategic level. Regardless of this one of the most important elements of the decision-making is not just the style itself but the ability to identify shifts between styles. The reason for this is relatively simple – the different styles have different strengths and weaknesses – and are therefore associated with particular biases and errors. The decision-maker needs to recognise the shift. This is why Stanovich et al's., (2007) 'initiate override' concept is so important because it is the mechanism by which the decision-maker changes their cognitive process.

The ability to be creative is associated with the ability to think 'divergently' or in different ways to those expected. Divergent thinking ability is eroded by fatigue (Horne, 1988) and some studies have shown a curvilinear trend in these abilities increasing through to around the age of 40 and declining after (McCrea et al. 1987). One of the primary reasons for this trend is because of the link between neurology and cognition – or the brain and thinking/deciding. This leads us to the concept of 'brain plasticity' – an emerging factor in decision-making and human cognitive performance more generally.

Brain plasticity refers to the brain's ability to change structure and function (Kolb and Whishaw, 1998). There are a range of anatomical changes including increases in synaptic connections, dendritic length and even metabolic rates that occur in the brain and change with experience. These changes are correlated with differences in behaviour (Kolb and Whishaw, 1998).

Various factors influence these experience-dependent changes including aging, gonadal hormones, trophic factors, stress, and brain pathology. Most importantly because the brain is 'plastic' the effect of factors such as aging can be 'turned back' to make the brain 'younger' – or rather to alter certain structures/functions to be more consistent with a brain that is younger. Mahncke et al. (2006) noted that it is now accepted that the brain retains a lifelong capacity for plasticity and adaptive reorganisation, and therefore dimensions of negative reorganisation should at least be partially reversible. They reported on a randomised control trial of a training program where the participant must perform increasingly more difficult stimulus recognition, discrimination, sequencing, and memory tasks under conditions of close attentional control high reward and novelty. The training required 60 min per day, 5 days per week, for 8-10 days. Results indicated an improvement in memory in the group that did the training, with the memory enhancement still observable 3 months post-training (Mahncke et al., 2006). These sorts of results have been replicated by Smith et al., (2009) who report improvements in auditory memory and attention.

As Kolb and Whishaw (1993) note, "The most likely mechanism for increased gene activity is neuronal activity, which is stimulated by behavior and experience. Activity initiated by experience or behaviour could therefore increase the activity of genetic mechanisms responsible for dendritic and synaptic growth and, ultimately, behavioral change (p.60)". If this project is to pursue more effective decision-making then it is essentially seeking to change behaviour and as, such, cannot ignore the physiology/neurology that underpins the cognition. Because of this, the project proposes a strategy that integrates cognitive decision tools with brain plasticity training in order to achieve the change we seek.

There are various links that might be explored between neurology/brain plasticity, cognition and decision-making outcomes, and just two are listed below:

Aspect of Brain Plasticity	**Associated Cognitive Effect**	**Application in EM**	**Possible training approach**
Greater cerebral blood flow, functional connections and structural plasticity associated with regions of the brain that deal with reasoning and memory.	Divergent thinking; various types of reasoning; improved memory	Being more creative in novel EM situations; improved ability to reason in difficult contexts; greater ability to hold details in memory	GIST test – *strategic attention, integrated reasoning*, and *innovation*
Increase in functional connections and structural plasticity associated with regions of the brain	Reduced attention tunnelling; (broader visual perception)	Ability to notice weak visual signals of team performance within an IMT/SOC/SCC at	Visual Field Test

that deal with Improved Peripheral vision.		periphery; ability to maintain an overall awareness of room.	
Increased grey matter volume in the mid-temporal area; alterations in occipital and parietal regions.	Improvements occur in visual motion perception and eye-hand coordination.	The applications in EM may be more appropriate on the fire ground where more manual work occurs. Further study is required to explore applications at higher levels of coordination.	Learning to Juggle

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