

Identifying Why Even Well-Trained Firefighters Make Unsafe Decisions: A Human Factors Interview Protocol

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Abstract

The primary cause of 80% of accidents and near misses in North American wildland firefighting has been attributed to human factors. Despite this overrepresentation of human factors in safety compromising situations, systematic research into such factors is scarce. In this paper we limit our consideration of “human factors” to those factors which influence how the human mind operates (i.e., “how people tick”). Such factors range from individual factors such as risk propensity to organisational factors such as a perceived safety culture. In this paper, we introduce a post-incident interview protocol specifically designed to reveal the human factors causes of potentially unsafe decisions in the context of Australian wildland fires (i.e., bushfires). In post incident interviews, serious challenges to obtaining accurate and comprehensive information are posed by problems of human memory and the tendency to offer self-protective justifications. We outline a multi-stage interview procedure, and associated interview techniques that are likely to maximize the quality and quantity of information obtained. The techniques that we outline will provide a powerful tool with which to investigate the rôle that human factors play in fireground safety. We suggest that this interviewing technique may also be applied in reviewing training exercises and in confidential “no fault” near miss and accident investigations where agencies are able to implement such systems.

Introduction

Reports of accidents, near misses, and demonstrably unsafe acts in the context of wildland (bushfire) firefighting identify human factors as the primary cause in 34% of cases and as a major cause in 80% of cases (Wildland Fire Safety and Health Network, 2004). Despite the overrepresentation of human factors in safety compromising situations, systematic investigation of such factors is both rare (Putnam, 2001) and sorely needed (Alexander, 2003).

The term “human factors”, broadly defined, refers to those factors which influence both how the human body operates (physiological factors such as dehydration, fatigue etc.) and how the human mind operates (psychological factors such as situation awareness, planning, trust in team members etc). Although many of the negative impacts of physiological factors on decision making are mediated by psychological factors (fatigue can be expected impair memory recall), there is compelling evidence that many psychological factors negatively impact on decision making in the absence of any identifiable physiological assaults.

The scarcity of systematic research into the mental processes which underlie decision making in wildland firefighting is not surprising given that such processes cannot be studied directly during the firefight, but must be studied retrospectively using interview techniques that cue memory recall. We suggest that the major issue contributing to the current lack of understanding of the role of human factors in wildland firefighting in particular, and safety-critical complex, time-pressured environments in general is the absence of an appropriate research methodology. In this paper we introduce an interview protocol that has been specifically designed to elicit the recall of the maximum amount of relevant information.

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Inclusion of Human Factors in the Formal Investigation of Wildland Firefighting Incidents and Accidents

Formal investigations of adverse events and serious near misses are routinely conducted by fire services throughout the world, reviewing the orders and actions of their firefighters on the fireground. In such investigations the main focus is on procedural matters, environmental conditions, and the state of equipment with the aim of providing fire service agencies with guidelines as to how they might operate more effectively and safely. Although such an investigative focus provides data of considerable value in allowing agencies to adapt operational procedures, equipment procurement, and training activities to reduce the likelihood of such mishaps occurring in the future, what remains relatively unclear are the mental (psychological) processes which generate safety-compromising orders and actions.

The wildland firefighting operational guidelines codified as “10 Standing Orders and 18 Watchouts” (10+18) have become a powerful influence in framing investigations into wildland firefighting in the United States. The 10+18 was developed in the United States as a training aid and operational heuristic. It comes directly from the operational experience of wildland firefighters and identifies the common failures which have led to firefighter deaths and accidents. Every US wildland fire investigation structures its findings around compliance with the 10+18. The strength of this framing has led to the comparative neglect of firefighters’ mental processes as a subject for investigation. While non compliance with one or more of the 10+18 may be noted, exploration of reasons behind such non compliance tends to be superficial or absent (e.g., the South Canyon Fire Report: Federal Bureau of Land Management, 1995). Some limited attempts have been made to include human factors in formal fire incident investigations (e.g., the Thirtymile Fire Report: United States Department of Agriculture, Forest Service, 2001). However, in light of the interview requirements for eliciting detailed information on human factors (outlined later in this paper) it is unlikely that the protracted and formal nature of such investigations allow the underlying psychological states and processes to be adequately identified, let alone investigated.

These observations are not offered as a criticism of the approaches adopted in formal accident/incident investigations. Most of the aims of a formal investigation of a specific incident are somewhat incompatible with the aim of identifying the deeper psychological factors and processes that influenced any observed orders and actions. As discussed in greater detail later in this paper, if one makes the focus of a post-incident interview the identification of potential breaches in procedural guidelines one is unlikely to create an interview climate conducive to a “full and frank” revelation of underlying psychological experiences and processes. Similarly, a focus on such private experiences is unlikely to lead by itself to a comprehensive account of the salient events and facts of any one incident.

There has only been one significant attempt to focus solely on the role of human factors in safety incident development, the SAFENET system in the United States (Wildland Fire Safety and Health Network, 2004). This is a self-reporting system that replicates to some extent the no-fault confidential incident reporting system in practice in the aviation industry by allowing anonymous reporting of safety compromising incidents and behaviours. However, unlike the current practice world-wide in the aviation industry, at present SAFENET has no interview component: firefighters complete a self-administered proforma and submit this electronically to the SAFENET website. The electronic reporting form to SAFENET asks if human factors matters contributed to an incident and implicitly invites elaboration of these in a section of the report devoted to an account of the incident. The absence of a trained interviewer limits the amount and the relevance of information recalled by the firefighter making it difficult to identify which particular human factors were primarily involved and how they may have operated.

We suggest that if safety on the fireground is to be enhanced, two complementary investigations need to be routinely conducted, one focused on the identification of suboptimal procedures, equipment, orders, and actions, and one focused on the human factors underlying such orders and actions. This difference in investigative focus is sufficiently great that interview methods appropriate for one are likely not only to be inappropriate for, but to actually distort, the findings of the other. Because of the likely incompatibility of the two investigative approaches, such complementary investigations may require that different persons be selected to conduct each such investigation.

Nature and Scope of Human Factors in Safety-Critical Contexts

The “human factors” approach to understanding how people interact psychologically and physiologically with complex task environments is particularly useful for understanding human behaviour in safety-critical situations, regardless of whether these are essentially man-made (e.g., an aircraft cockpit) or naturally occurring (e.g., a wildland fire) (cf, Johansson, Hollnagel & Granlund, 2002). Task-related psychological processes range from basic interactions with the task environment via perception and attention, through the processes which comprise memory functioning, to the complex functions of reasoning and judgment. The operation of these task-related psychological processes are modified by the operation of a range of predisposing physiological states (such as fatigue, nutrition, and hydration) and predisposing psychological orientations (such as self-confidence, morale, and anxiety).

The role of human factors in safety compromising incident investigation has been the subject of intense interest in military and civil aviation. As the fireground is a complex environment that shares many features in common with adverse aviation incidents, we have drawn on the extensive literature on aviation incidents and accidents to provide a classification of human factors potentially applicable to fireground decision making.

We have found two frameworks to be particularly helpful in creating a comprehensive classification of psychological human factors potentially applicable to the fireground. These frameworks, developed to identify human errors in aviation accident and incident investigation, comprise the Human Factors and Analysis Classification System (HFACS) (Shapell & Wiegmann, 2000; United States Naval Safety Center, 2003) and the Technique for the Retrospective and Predictive Analysis of Cognitive Errors (TRACER) (Shorrock & Kirwan, 2002). The provisional classification of human factors which underlies our proposed interview protocol, the first version being presented by Reynolds, Omodei, McLennan, and Wearing (2004), is summarised in Table 1. Note that this list does not necessarily include all relevant human factors and that we expect the list to be amended as other human factors emerge with use of the interview protocol. This proposed human factors classification emphasises factors that operate within the individual to influence behaviour, but examines these within the context of the effects on the individual of their immediate crew and/or brigade members (Small Group factors), and of their fire service and/or community (Large Group factors).

We have divided the individual factors into three broad categories: (a) factors that are in play before action takes place (predisposing mental and physiological states); (b) factors that directly enable decisions to be made (perception, memory, judgment); and factors that directly enable decisions to be executed (communication and action execution).

The Small Group factors include the effects of interpersonal dynamics on individual behaviour. These generally fall into the area of leadership and small group dynamics. The Large Group factors are the broader, relatively more enduring, factors that reflect the firefighter’s perceptions of the expectations of the fire agency and community to which he or she belongs.

Table 1. Framework for classification human factors potentially associated decision making safety in firefighting

	Factors	Examples
<u>Individual Factors</u>	Predisposing Physiological States	Fatigue
		Affected by alcohol, drugs, or medications
	Predisposing Mental States	Dehydrated
		Hungry
		Ill or injured
		Physical fitness
		Emotions (e.g., morale, enthusiasm, worry, stress)
	Perception	Motivation (e.g., personal goals, perceived rewards, perceived sanctions)
		Personality orientations (e.g., optimism, risk tolerance)
	Memory	Attitudes (e.g., personal values, expectations, preferences)
Vision		
Decision making	Hearing	
	Perceptual information	
	Previous actions	
	Immediate/current situation	
Communication	Future actions	
	Knowledge base (e.g., operational procedures, fire concepts)	
	Mental workload	
Action execution	Situation assessment	
	Judgment	
<u>Small-Group Factors</u>	Communication	Planning
		Action selection
	Action execution	Self-monitoring and self-regulation (with respect to the adequacy of one's own performance)
		Accuracy
	<u>Large-Group Factors</u>	Clarity
		Conciseness
		Timeliness
		Timing
		Positioning
		Execution
Interpersonal climate		
Leadership		
Followership		
Trust/Mistrust		
Respect		
Familiarity		
Communication		
Team Cohesion		
Team Dynamics		
Doctrine		
Culture		
Expectations		
Values		
Trust/Mistrust		
Respect		

Points for Identification of Human Factors Contributions to the Development of a Safety Incident

In order to determine the points in the developmental trajectory of an incident that afford opportunities for interviewing to understand the human factors contributions to safety threats, we propose an Incident Threat Severity Spectrum (ITSS). Figure 1 outlines the basic structure of this ITSS, charting the progression of an incident from its beginnings to a serious event.

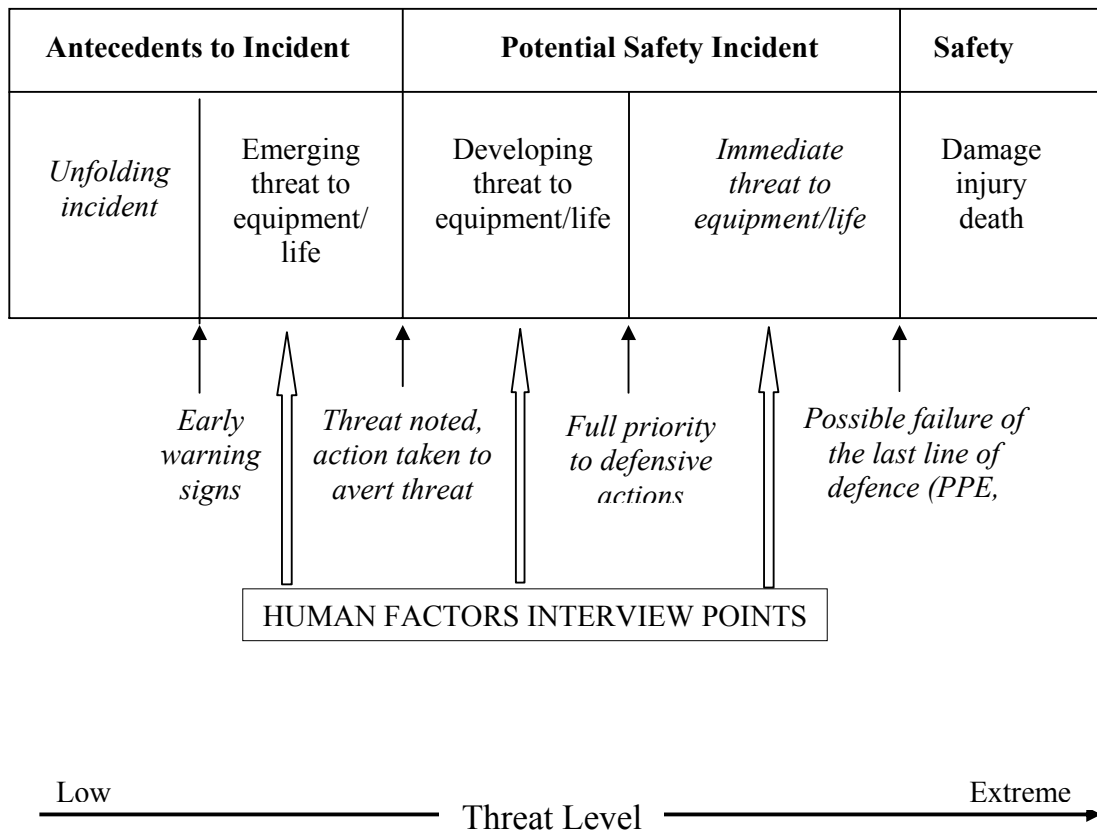


Figure 1. Incident-Threat-Severity Spectrum (ITSS): the development of a safety threat, decision points (in italics), and human factors interview points.

The range of threat severity covered by the ITSS ranges from mild, where on later reflection the incident may be said to have begun, to extreme where damage, injury or death has occurred. The “unfolding incident” refers to the very earliest stage at which an evolving safety threat is potentially, but not readily, detectable, with most incidents never developing beyond this level of safety threat. The next stage of increasing threat is the emergence of the threat, where the constituents of a potential safety incident and their interactions are now readily discernible. The developing threat has become apparent requiring defensive action to be taken to prevent escalation of the safety incident. The stage of most extreme threat is the safety incident itself, where the processes causing injury damage or death are now underway. As can be inferred from Figure 1, human factors are involved in all stages in the development of a safety incident, from the early awareness of the need to be alert to the possibility of a safety threat to the need to deal with serious loss of life or property. Consequently, as shown

in Figure 1, there are several points in the developmental trajectory of a safety incident at which interviews could usefully be conducted to determine the operation of human factors that lead to decisions that compromise safety.

Note that the experiences of all firefighters (regardless of rank) can be understood with respect to such a developmental trajectory of a safety incident. That is, regardless of how benign the incident may currently appear with respect to safety threats, all operational ranks need to explicitly pay attention to identifying potential safety threats in making decisions and/or carrying out instructions appropriate to their respective positions in the command chain.

With respect to our primary goal of enhancing understanding of the human factors which impact on safety-relevant decision making, we therefore conclude that useful information can be obtained by interviewing persons of all rank after incidents of all levels of severity. We have, however, already indicated that the focus and methods involved in a formal operational investigation are sufficiently different from a human factors investigation as to render participation in one likely to introduce distortions in the other. Therefore research into the human factors underlying safety is best undertaken with persons who have not been, nor are likely to be, involved in a formal operational investigation. As serious incidents typically require all relevant persons be included in the formal investigation processes, we therefore recommend that any proposed human factors interview protocol avoid serious incidents, focusing on those incidents in which, although there was the opportunity for an adverse outcome, steps were eventually, if not initially, taken to avoid the development of a serious incident.

This raises the question as to whether a human factors analysis of minor safety incidents can produce findings that generalise to more serious safety breaches. Fortunately, although no two fires are the same, the underlying psychological characteristics of the human firefighter remain relatively constant across fires regardless of level of seriousness of the safety threats involved. Consequently, any findings and recommendations which emerge from an investigation of safety-related human factors at relatively benign fires can be expected to generalise to other fires, including those that pose serious threats to safety and, in fact, progress to severe adverse outcomes. The opportunity to reveal safety deficiencies in the absence of the actual occurrence of an adverse event is reflected in the concept of “latent failures” (cf Reason, 1997). As Weick and Sutcliffe (2001, p. 13) have indicated, such latent failures can be detected if careful attention is given to taking advantage of the “free lessons” which reside in superficially non problematic (normal) incidents. We therefore believe that the human factors interviewing approach we outline here will provide useful information on the human factors contributions to safety compromising situations of all levels of severity.

Issues in Interviewing to Reveal the Operation of Human Factors

Essentially the challenge is to develop a post incident inquiry method which reveals comprehensive and accurate data about those psychological processes which generated directly observable orders and actions that possess the potential to compromise safety. This challenge is not a trivial issue. Indeed, Woods and Cook (1999) went so far as to argue that the operation of hindsight bias (knowledge of outcome biases our judgements about the processes that generated the outcome) renders useless most current applications of post-incident accident reporting as a means of understanding and preventing errors. While such a radical rejection of post-incident reporting as a data gathering methodology may be extreme, there are grounds for calling into question the comprehensiveness and accuracy of data generated by conventional interview or survey questionnaire methods for eliciting post-incident retrospections.

Omodei, McLennan and Wearing (2004) suggest that typical strategies for obtaining retrospective self-reports, such as structured interviews and surveys, cause some psychological processes to be much more likely to be recalled than others, leading to a distorted understanding of the decision making process in general, particularly when there is the possibility of decision maker error. What is least likely to be recalled are those perceptual, affective and motivational states that are essentially pre-verbal or at least not verbalised during the flow of the decision incident in question. There is abundant evidence, both anecdotal and experimental, of a pervasive human tendency when providing self-reports to present an image of the self that is both self-enhancing and self-consistent, via processes of distortion and censoring (e.g., Swann, Griffin, Predmore, & Gaines, 1987). Thus, those experiences least likely to be recalled are those associated with actual or potential errors precisely because such experiences constitute a negative self-assessment and, as such, are subject to self-enhancement/protection processes (Omodei, Wearing, & McLennan, 2002). It should also be noted in light of the discussion in the previous section concerning incident severity, that the greater the apparent severity of an incident, the greater the pressure for such distortion and censoring in post incident recollection. Clearly, what are needed are interview methodologies that are capable of generating comprehensive verbal protocols which are as free as possible from serious self-referent distortion.

The literature on human memory processes (Matlin, 2002) indicates that comprehensiveness (quantity) and accuracy (quality) in memory recall will occur only if the following main requirements are met: (a) the presentation of adequate memory cues, (b) the minimisation of potentially interfering recollections, and (c) freedom from criticism, censure, or embarrassment. It is important therefore that interview procedures and guidelines be adopted which meet each of these requirements. It should also be noted that those fire incident investigations and reporting systems that do make some provision for the inclusion of human factors (discussed in a previous section of this paper) do not adequately meet these three requirements.

Methodology

Drawing on the literature on human factors in decision making in general and the literature on human episodic memory in particular, we have developed "The Human Factors Interview Protocol" (HFIP) to maximize the quality and quantity of information obtained in post-incident interviews. These guidelines include many of the key elements of Klein, Calderwood, and MacGregor's (1989) critical decision method; and Omodei, McLennan, and Wearing's (2004) two-stage cued recall technique.

To promote the recall of the maximum amount of relatively uncontaminated information, particularly in the early stages of the interview, the primary interviewing technique is to encourage the interviewee (i.e., the firefighter) to maintain during his or her recall an own-point-of-view or "insider" recall perspective:

Inner perspectives: The purpose of interviewing is to find out what is in and on someone's mind. The purpose of open-ended interviewing is not to put things in someone's mind (for example the interviewer's preconceived categories for organizing the world) but to access the perspective of the person being interviewed (Patton, 1990, p. 278).

That is, what is of interest is how the situation was experienced, at the time, by the firefighter, rather than how it might, or even should, appear now to an outsider, including to an interviewer. From the literature on interviewing techniques that promote such an insider perspective (e.g., Ivey, 1994; McLennan & Miller, 2000) this is achieved by the interviewer

adopting as his or her primary goal an attempt to understand the interviewee's experiences from the perspective of that interviewee. This is achieved, first, by adopting a stance of courteous, attentive, non-judgmental, interested curiosity in the experiences of the firefighter being interviewed. The interviewer then proceeds by using, mostly, leads which are facilitative of recall rather than interrogatory: open-ended questions, invitations to say more, encourages, and paraphrasing to check accuracy of the interviewer's understanding of what is being described. Although beyond the scope of this paper, this approach to interviewing has a distinguished lineage, deriving from early work by interviewing and counselling educators such as Rogers (1952) and Kagan (1984).

In order to create an interview climate conducive to the detailed recollection and reporting of relevant experiences, the following multi-stage interview sequence is recommended in which the person progressively revisits the incident with the recollections at early stages providing a stimulus and climate conducive to more detailed and reflective recollections at subsequent stages

1. Set the parameters: Outline the structure of the interview and the steps that have been put in place to ensure confidentiality of any information obtained.
2. Elicit the narrative and its chapters: Obtain an overall description of the incident in the form of a "story line" or narrative, with key events to constitute "chapters" or "episodes" in this narrative. Use of existing incident maps or the creation of illustrative 'mud maps' or diagrams usually assist the person being interviewed by priming or cuing recall of important events and psychological experiences. Encourage the interviewee to identify "chapters" for more detailed recollection. For all interviews, it is important that the first chapter always be the 24-hour period prior to and including receiving notification of the incident.
3. Collaborative analysis of the chapters: This is the core of the interview, taking the largest portion of the time allocated to the interview. Encourage the interviewee to reflect on each chapter in turn in order to recollect and recount in as much detail as possible his or her experiences at the time, each such recollection acting as a cue to the recollection of subsequent experiences. The interviewer should be alert to possible decision points, particularly those that have implications for safety, and to assist the interviewee to elaborate on these in particular. The primary role of the interviewer is to provide minimal probes to elicit as wide a range of experiences as possible, and to assist the interviewee to avoid censoring recollections for accuracy or relevance, hindsight observations, self-evaluation, and self criticism. Use probes to encourage the recollection of the following:
 - What was noticed and paid attention to
 - Understanding of the situation and what was expected to occur
 - Any general concerns and feelings
 - Any particular safety concerns or issues
 - Specific decisions and plans
 - Intentions formed and actions initiated
4. Stepping back - the wisdom of hindsight: Encourage the interviewee to provide now, with the value of hindsight, a critical analysis of the experiences recalled in the preceding phase. Specific interviewer questions are used to obtain information on each of the following:
 - a. What the person believes they should have done differently
 - b. What the person believes could have gone wrong but didn't

Both of these probes provide the interviewee with an opportunity to identify ways in which human factors might have led to the progression to a more serious incidents.

The two probes typically result in generating a large amount of relevant, and sometimes unexpected, information

5. 'Anything else?' check: Give the interviewee the opportunity to raise any other events or issues of importance that might have been overlooked so far during the interview. Previous experiences with similar incidents should be explored here.
6. Bigger picture: Encourage the interviewee to provide an account of their experiences of the overall climate of their work group (e.g., Brigade or Crew). Specific interviewer questions are used to obtain information on matters bearing on safety. This question also generates a substantial amount of relevant, and often unexpected, information relevant to human factors.
7. Even bigger picture: Encourage the interviewee to provide an account of their experiences of the overall culture of the Fire Agency to which they belong. Here also, specific interviewer questions are used to obtain information on matters bearing on safety. As for the previous question, this question also generates a substantial amount of relevant, and often unexpected, information.
8. Wrap up

It should be apparent from the elements of the interview procedure outlined above (the eight-fold path to enlightenment!) that for the interview to be maximally effective, it is important that the interview takes place as soon as practicable after the incident (while experiences are fresh/readily recalled) and that total confidentiality be assured (to reduce fear or criticism, censure, or embarrassment). Note that such confidentiality assurances are only possible if neither the firefighter, the fire incident, nor the fire agency are able to be identified in any reports of findings.

Preliminary Findings

Although our own use of the Human Factors Interview Protocol in wildland firefighting contexts is still in its 'proving' phase, we are able to provide the following preliminary findings.

In the immediately preceding wildfire season (Southern Hemisphere Summer) we have piloted the interview protocol in 7 separate wildfire incidents, obtaining 22 separate interviews with fire officers ranging from Crew Leader (in charge of a 5-person crew on a single appliance) to Incident Controller (in charge of an Incident Management Team for a large scale fire).

Seven interviewers, who had only brief training in the application of the interview protocol, performed these interviews. All interviewers reported little difficulty in implementing the protocol, although considerable flexibility was reported to be required to take into account the considerable variability in the nature and size of the incidents involved and the physical environments in which the interviews took place.

In reviewing the transcripts of the 22 pilot interviews the following themes, with clear implications for the impact of human factors on safety, have emerged. Nevertheless caution should be exercised in interpreting any findings at this early stage. These preliminary findings are offered here only in so far as they illustrate the sort of information that is likely to be elicited by the multi-stage interview protocol.

1. A lack of trust in information provided by firefighters they did not know personally was consistently reported. This lack of trust applied to persons both above and below the firefighter being interviewed in the command chain. One of the main behavioural indicators of such lack of trust was the tendency to go outside of the formal command chain to obtain information, further eroding not only trust but also morale.

2. Despite the acknowledged need for detailed and accurate briefings at shift changeover, there appeared reluctance on the part of both outgoing and incoming shift personnel to engage in such briefings. The result of such cursory and inadequate changeover briefings created particular difficulties when operating in unfamiliar terrain and at night.
3. Another common finding was that persons in field command roles (particular local incident command) experienced significant mental overload but were reluctant to recruit personal support of a dedicated assistant, or to escalate the level of the incident by activating a formal Incident Management Team.
4. Finally, despite the general awareness of, and concern with, the effects of fatigue and dehydration in summer fires in difficult terrain, the primary focus on getting the job done appears to override any such concerns. This appears to be particularly so in those fires where firefighters' own property, or that of his/her neighbours, is threatened by the fire. It should be noted that in Australia, most wildland fires are fought by volunteer brigades that recruit their volunteers from the local community.

Conclusion

In this paper we have outlined an interview protocol to discover, in as much detail, and with as much accuracy, as possible those psychological experiences and processes that underlie potentially safety compromising decisions and behaviours on the fireground. As the interview procedures differ from most that are currently in use in fire-agency mandated investigations, it should be emphasised that interviews conducted according to this protocol are quite different from, and therefore should not be seen as replacing, current hot debriefs, after action reviews, critical incident stress debriefings, or other post-incident reporting procedures. We do, however, suggest that this interviewing technique can also be applied in reviewing training exercises and in confidential "no fault" near miss and accident investigations where agencies are able to implement such systems.

From our previous experience researching complex decision making in computer-simulated wildfire scenarios (Omodei, Elliott, & Walshe, 2004) we conclude that the only minor alterations to the protocol are required to achieve maximum learnings from computer-simulated training exercises, sand-table exercise, and tactical decision games.

The task of determining why good firefighters sometimes make unsafe decisions is complex. We believe that the interview approach outlined in this paper is likely to lead to findings and recommendations that will enhance safety, not only in wildland firefighting, but also in a wide range of industry and emergency settings that require persons to work in safety-critical task environments.

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Mary Omodei gained her doctorate in 1993 from the University of Melbourne, Australia, in cognitive psychology. Since 1994 she has held an academic research and teaching position at La Trobe University, Melbourne. Her overall research program focuses on decision making in complex socio-technical systems, including military command and control and emergency management. The research has led to the development of a range of complementary methodologies, including: 1) the programming of Networked Fire Chief, a networked forest firefighting simulation program; 2) the development of more sensitive interview methods for investigating emergency incident decision making; and 3) the development of head-mounted video cameras for non-invasively monitoring of decision making in field settings. Mary's current research interests include (a) the identification and mitigation of the human factors causes of unsafe and/or ineffective Fire Ground and Incident Management team decisions and (b) the use of computer simulated wildfire scenarios for research and training in Fire Ground and Incident Management Team decision making. She is the leader of the "Safety in Decision Making and Behaviour" Project in the Australasian Bushfire Cooperative Research Centre (see www.bushfirecrc.com) and is the coordinator of the Melbourne Complex Decision Research Group (see <http://www.latrobe.edu.au/psy/research/cdrg/index.html>).