THE HUMAN FACTORS APPROACH: WILL IT HELP EMERGENCY RESPONDERS MAINTAIN SAFETY AT AN INCIDENT?

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ABSTRACT

Responding to emergencies often confronts responders with potentially stressful and dangerous situations in dynamic and unpredictable environments. Agencies such as fire, police and ambulance are faced with the dilemma of how risk is managed. In order to meet OHS legal obligations new ways of looking at the way business is done have emerged – one being, addressing the human factors impact on the management of safety. Research into, and the application of, a human factors approach to aid in the management of safety is gaining strength in fire management agencies. Following the 'South Canyon Fire' in the US in 1994 Fire Management agencies there increased the focus on understanding the impact of a 'human factors' approach and how this applied to emergency response and thus improving firefighter safety. This paper discusses the need to understand what 'human factors' means in the context of operations. A review of current research into risk perception and decision-making details an emerging approach to aiding the safety of emergency responders in risky situations. The need to integrate this approach into other aspects of safety management, rather than being a stand-alone concept, is discussed.

The traditional approach to the control of human factors in safety is the "safe place" approach, in fact an underpinning philosophy of workplace safety legislation attempts to enforce a "safe place" by controlling risks at the source by eliminating them as a first priority. The "safe place" approach is best demonstrated in advances in equipment design that have been seen in recent years. Firefighting vehicles are vastly different in design to that of 25 years ago. Vehicles now have roll over protection (ROPS), heat shielding, diesel motors that prevent fuel vaporisation and many other design features that are integrated to ensure that hazards associated with manual handling are addressed in the design stages. Personal protective clothing and equipment (PPC/E) have also undergone significant change. Helmets and firefighting apparel such as boots and clothing are now provided that are environment specific eg. structural, wildfire or rescue. In more recent times the impact of fatigue and hydration levels has come under significant scrutiny with research currently underway attempting to determine the impact of these factors on human activities.

Fire services have adopted a program titled the "safe person" approach, first developed in Britain in the mid 90's and later introduced into a number of fire services in Australia. With the safe person approach aspects of safety are identified both at the organisational and individual level. At the individual level, components focus highly on training, PPE/C and behavioural aspects, encouraging individuals to speak up when they believe something is wrong or they are not skilled for the task they are appointed. In contrast to the "safe place" approach, a "safe person" approach seeks to maximise safety in the workplace by ensuring that the human operator is as well equipped to deal with hazards as possible, usually through intensive training and adherence to Standard Operating Procedures (SOPs). However, even this approach pays little explicit attention to the limitations of cognitive functioning, but rather focuses on what an individual's behaviours or actions should be.

The problems with either of the above approaches to safety in emergency services are:

1. By their nature, emergencies , such as a fire, are not readily predictable, are often unstable, and require a dynamic response as the situation unfolds. It is therefore impossible to develop SOP's, which will cover all contingencies in an emergency situation, and a great deal of reliance is placed on the capacity of the individual human operator to respond to the situation.
2. Both a "safe place" and a "safe person" approach are limited because they doesn't take into account the limitations of the human operator as an engineering challenge. Human performance in emergencies will vary between individuals depending upon such things as training and experience and individual performance will vary across situations depending upon situational factors such as fatigue, etc. Given that human performance in an emergency situation is likely to be highly variable, any safety measures must take this factor into account.

We suggest that a human factors approach is needed to take account of the human limitations in the system, not just the environment in which that human operates. One basic premise for managing safety from a health and safety perspective is to use the hierarchy of safety controls (Figure 1 below)

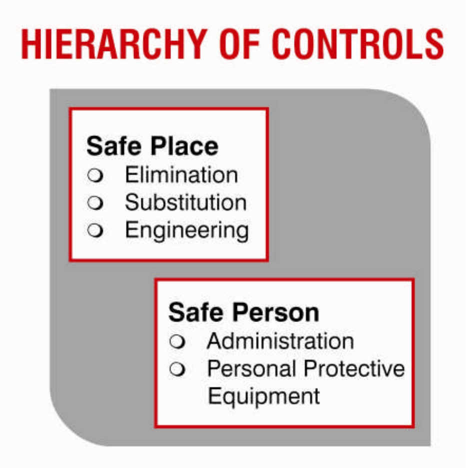

Figure 1 - Hierarchy of Controls (Clancy, 2004)

By applying the hierarchy of controls a progressive approach to managing hazards is achieved, that is, the first and most effective way in managing a hazard is to eliminate it, and the least effective way is to provide personal protective equipment/clothing (PPE/C).

Elimination of a hazard however is not always possible and certainly this is the case for the firefighting environment, although firefighters set out to achieve just this, their work environment will remain hazardous.

Traditionally it has been the three lower levels of the control hierarchy (engineering, administration and PPE) that fire services have applied to managing firefighter safety. Fire services have tended to rely heavily on the lower end of the control hierarchy for firefighter safety with a significant focus on the "safe person" type approach.

During the Coronial Inquiry into the deaths of 5 firefighters at Linton, Victoria, when discussing the problems associated with the traditional hierarchy of controls and its application to fire services, the Victorian States Coroner (2002) found that *"… the nature of the potential hazard in wildfire dictates a combination of all practicable systems to ensure the risk of injury or death is reduced."*(p.607). The State Coroner (2002) made the recommendation that both the Country Fire Authority (CFA) and Department of Natural Resources and Environment (DNRE) *"…develop a modified set of Hierarchy of Controls relating to firefighting and wildfire to assist those working in the area towards improving the general understanding of the application of occupational health and safety and related risk management principles."* (p.607)

There are many examples from the fireground of human factors defeating both an engineering approach and training. One example is the South Canyon, Colorado, fire where 14 firefighters lost their lives. Despite extensive training and experience these firefighters were consciously aware that they were violating SOPs, yet chose to remain in a dangerous situation which ultimately lead to their deaths (MacLean, 1999). Similarly, numerous violations of SOPs occurred at Linton, Victoria, which contributed to 5 firefighters losing their lives. The best written SOPs are of little use if humans fail to adhere to them. It is obviously important to consider the question of what factors contribute to human-beings operating unsafely despite the best engineered efforts to ensure a safe workplace environment. We need to understand why people violate SOPs and how this can be rectified.

Often in situations where human factors do defeat engineering and administrative controls 'human error' is flagged as a cause, this thinking, however, has been the subject of considerable review and discussion (Reason , 1990; 1997; Dekker, 2002; Strauch, 2002). As stated by Reason (1997) *"The term human error conveys the impression that all unsafe acts can be lumped into a single category."* whereas *"…errors take different forms, have different psychological origins, occur in different parts of the system and require different methods of management."*(p.61). The key point is that there is a need to understand where weaknesses exist in a humans cognitive processing capacity by having a *"…better understanding of mental processes"* (Reason, 1990, p.1) and determining the *"…predictable varieties of human fallibility."* (Reason, 1997, p.1).

Emergency situations are typically chaotic, time pressured, noisy, physically demanding and stressful situations where decisions need to be made rapidly. The inherent limitations of human information processing capacity are well known within the discipline of psychology. Working memory (the amount of information we can hold in our head at any one time) under optimum conditions is limited to 7 +/- 2 concurrent items of information (Miller, 1956). This means that, even in the best circumstances, human information processing capacity is readily overwhelmed by incoming information.

The capacity of working memory is further reduced when human beings are subjected to noise and radio traffic (Surprenant, 1999; Potter, 2000) and when subjected to stress (Baddeley, 1972; Crowe, Hale, Dean, El Hadj, MacDonell, Sarkissian & Wrigley, 2001). Even the process of deciding which pieces of information in the environment are important, and which should be ignored, taxes the capacity of working memory (Conway, Tuholski, Shisler & Engle, 1999).

It is well established that, in dangerous environments, decision-making becomes more prone to errors and attention tends to become narrowly focussed on a few salient features of the environment at the cost of peripheral information (Baddeley, 1972). Under conditions of high stress and physiological arousal attentional capacity is likely to focus only on that which is seen and heard directly in front of us (Crowe et al, 2001; Al'Absi, Hugdahl & Lovallo, 2002).

The implication of this is that safety systems cannot rely on the capacity of the human operator to rapidly process large amounts of information and that once the operator is placed under stress, as in an emergency situation, decision-making performance is likely to be badly compromised. Fire services have made some effort to address this by developing the 10 Standard Fire Orders and 18 Watch-out Situations as heuristics/mnemonics to alert firefighters to danger in a wildland environment, however even these, unless highly routinised in long term memory, are likely to exceed information processing capacity on the fireground. The research of Braun, Gage, Booth and Rowe (2001) has demonstrated that recall of these orders can be significantly improved by combining related concepts so that the number of items of information that need to be recalled is reduced. However alternative methods of ensuring recall of the 10 Standard Fire Orders and 18 Watch-out Situations have yet to be adopted by fire services.

Recent research has focussed on the role of situation awareness (SA) (Endsley, 1995; Endsley, Holder, Leibrecht, Garland, Wampler & Matthews, 2000) in the process of dynamic decision-making. We argue that research into SA also has important implications for safety in emergency situations. SA is theorised to have three components: 1. Perception of the elements of the environment; 2. Comprehension of the current situation; and 3. Projection of future status of the environment (Endsley, 1995). In order to operate safely in an emergency environment obviously accurate perception, comprehension and projection by the human operator of the environment are necessary. Apart from the effect of cognitive load, noise and stress on working memory there are many other human factors that are likely to influence the capacity of an operator to maintain accurate SA.

Individuals will differ in their capacity to perceive, comprehend and predict the situation depending upon levels of training and expertise (Endsley et al, 2000). Those with greater training and experience will have developed richer cognitive schemas and mental models to draw upon in comprehending a situation (Ericsson & Lehmann, 1996). Human beings vary enormously in their perceptions of a situation based on their previous knowledge, training and experience (Endsley et al, 2000). This means that measures for ensuring safety in emergency situations cannot assume that all operators will perceive the same information in the same way. In addition, those who lack training and/or experience of a situation and so have no developed schemas to assist in SA are likely to be oblivious to the fact that their situation awareness is poor, thus further compromising their safety. Arguably it has been the inability to project the future status of the environment and predict future wildfire behaviour that has been most important in contributing to deaths on the fireground

Because human information processing capacity is limited humans seek to reduce cognitive load and complexity by relying on a number of cognitive shortcuts, such as heuristics or "rules of thumb" (Kahneman, Slovic & Tversky, 1982). If an operator has a great deal of experience dealing with a domain these heuristics will contribute to rapid information processing and effective performance (Ercisson & Lehmann, 1996). However human decision-making tends to be prone to a number of cognitive biases and even experts have been found to be subject to biases in their decision-making (Cleaves, 1987). For example, expert firefighters have been shown to make inaccurate predictions about likely fire behaviour depending upon whether the fire is framed as a wildfire or a prescribed burn (Lewandowsky & Kirsner, 2000). One of the most common biases seen in emergency decision-making is the "sunk-costs" bias where a course of action is relentlessly pursued despite the fact that the situation is deteriorating. Another typical decision-making bias in emergency situations is an "overutilisation of resources" bias where Incident Controllers reduce the effectiveness of their performance by seeking to utilise all appliances and all available information rather than making appropriate judgements about resource and information utility (McLennan, Omodei, Holgate and Wearing, 2003).

Poor situation awareness and the likelihood of cognitive biases in decision-making are likely to substantially affect a person's perception of risk in an emergency situation. There has been insufficient research to date to come to any firm conclusions about what individual factors are most likely to influence risk perception. Most studies have found that greater experience leads to more accurate risk perception (Barnett & Breakwell, 2001, Clancy and Holgate, 2004).

We argue that future research into safety management should take account of our existing knowledge of human factors in designing safety programs. Future research needs to address such questions as:

1. Given the known limits of information processing capacity how can existing safety awareness programs be better designed to account for that fact.
2. Given the effect of stress on decision-making performance how can we better train people to deal better with stress in an emergency situation.
3. What are the typical biases to which emergency decision-makers are most prone and can we train people to avoid them
4. What are the most important factors in compromising situation awareness in an emergency and how can these be addressed.
5. What factors most influence the accuracy of individual risk perception.

CONCLUSION:

The safe handling of emergency situations typically relies on the individual judgement of Incident Controllers (I.C.'s) at a strategic level to determine strategy on controlling an event but individual operators are also required to assess their immediate environment and make decisions based on their own knowledge. Rather than taking an engineering approach to improving safety in emergency situations we argue a need for greater understanding of the processes that go into the kind of judgements of risk that I.C.'s and individuals throughout an incident management structure make. By understanding the frailties of human cognitive processing, training programs can be developed that take into account human fallibility and design training that targets not only how things should be done but where we may make mistakes and why.

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