The fifth age of safety: the adaptive age

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ABSTRACT

It has been argued that OHS has developed and evolved through a technical age, a human factors age and a management systems age or through a technical wave, a systems wave and a culture wave. A fourth age of safety has been described as the integration age. As the limitations of OHS management systems and safety rules that attempt to control behaviour are becoming evident, it is proposed that we are moving into a fifth age of safety, the 'adaptive age'; an age which transcends rather than replaces the other ages of safety. The adaptive age embraces adaptive cultures and resilience engineering and requires a change in perspective from human variability as a liability and in need of control, to human variability as an asset and important for safety. Embracing variability as an asset challenges the comfort of management. However, the gap between work as imagined and work as performed and the failure of OHS management systems and safety rules to adequately control risk mean that a new perspective is required.

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INTRODUCTION

This paper presents a review of existing and emerging approaches for managing occupational health and safety (OHS) and puts forward the view that, under certain circumstances, more adaptive approaches to managing OHS are required.

Hale and Hovden (1998) have argued that OHS has developed and evolved through three so-called 'ages of safety'. The first age was a technical age, the second a human factors age and the third a management systems age. A different sequence of development was put forward by Hudson (2007), who suggested that safety has evolved through three waves. The first was a technical wave, the second a systems wave and the third a culture wave. Both of these views suggest that the process of development has been sequential. Glendon et al. (2006) posits an alternative view, that each period of development does not leave behind, but rather builds on, what has gone before. He refers to this process of development as the fourth age of safety or the 'integration age' where previous ways of thinking are not lost, but remain available to be reflected upon as multiple, more complex perspectives develop and evolve.

Notwithstanding the suggested integration age (Glendon et al., 2006), it may be timely to introduce the possibility that we are moving into a fifth age of safety or an 'adaptive age'. The adaptive age transcends all other ages without discounting them, whilst introducing the concept of 'adaptation', the adaptive age goes beyond simply integrating the past. This notion is informed by current discussions around resilience engineering (Hollnagel, 2006)

and 'efficiency-thoroughness trade-offs' (ETTO) (Hollnagel, 2009a) that take us beyond the contemporary ways of thinking about managing OHS that typically focus on OHS management systems (OHSMS), safety culture and safety rules.

BEYOND OHS MANAGEMENT SYSTEMS TO ADAPTIVE CULTURES

Increasingly, the limitations of an over-emphasis on documented management systems have started to emerge. Robson et al. (2005) in their systematic review of health and safety management systems found that "there is insufficient evidence in the published, peer-reviewed literature on the effectiveness of OHSMSs to make recommendations either in favour of or against OHSMSs" (p. 9). The 1999 Report of the Longford Royal Commission into the explosion at Esso's Longford gas plant in Victoria found that although Esso had a world class OHSMS, the system had taken on a life of its own, "divorced from operations in the field" and "diverting attention away from what was actually happening in the practical functioning of the plants at Longford" (Dawson & Brooks, 1999, p. 200).

Similarly, Hopkins (2007), in his analysis of the 1996 Gretley mine disaster concedes that "experience is now teaching us that safety management systems are not enough to ensure safety" (p. 124). Further, a 2007 report commissioned by the New South Wales Mines Advisory Council argued that an OHSMS should be built on the principles of mindfulness and not be a "complex, paper-based OHS management system" (p. xiii).

Reason (2000) contends that managers believe that OHSMS sit apart from culture. He suggests that an over-reliance on systems and insufficient understanding of, and insufficient emphasis on, workplace culture, can lead to failure because "it is the latter that ultimately determines the success or failure of such systems" (p. 5).

Safety culture has emerged as a major focus in improving OHS performance. Hopkins (2005) argues that this stems in part from recognition of the limitations of OHSMS. In his analysis of the 1999 Glenbrook train crash involving a commuter train and the *Indian Pacific*, Hopkins identifies the danger of a culture of rules, a culture of silos, a culture of on-time running, together with the related dangers of a culture that is risk-blind or risk-denying. These are matters that are outside the scope of traditional OHSMS and it may be that OHSMS mask the emergence of these cultures which become all too readily available to see with hindsight.

Hopkins (2007) views safety culture as one aspect of organisational culture, or more particularly an organisational culture that is focused on safety. Further, culture is viewed; as a group, not an individual, phenomenon; efforts to change culture, should, in the first instance, focus on changing collective practices (the practices of both managers and workers) and the dominant source of culture is what leaders pay attention to. Much of Hopkins work draws on Reason's (1997) notion that a safe culture is an informed culture and Weick and Sutcliffe's (2001; 2007) principles of collective mindfulness.

Reason (1997) argues that culture can be socially engineered by managers and that a safe culture is an informed culture. He argues that in navigating the safety space between increasing vulnerability to risk and increasing resistance to risk, organisations should strive for maximum resistance to risk (as opposed to the unobtainable goal of 'zero risk'). He goes on to argue that there are three cultural drivers that allow organisations to achieve maximum resistance to risk: (i) Commitment reflected in the provision of resources to mitigate risk, even in tough times; (ii) Cognisance reflected in an awareness of the dangers that threaten operations; (iii) Competence gained from an information system that provides managers with an understanding of where they are relative to the edge of safety without having to fall over it first.

The latter point is achieved through the engineering of an informed culture and in

Reason's view; an informed culture is a safety culture. An informed culture is made up of the four interlocking sub-cultures of a reporting culture, a learning culture, a just culture and a flexible culture.

Hudson suggests (2007) that safety culture evolves and may be represented by a five step ladder of distinct stages: pathological, reactive, calculative, proactive and generative. Progression up the ladder is associated with increasing trust, accountability and informedness (as in Reason's informed culture). What remains unclear is how organisations move from one step on the ladder to another.

An alternative view suggests that culture is not homogeneous within organisations and can be both differentiated and fragmented (Richter & Koch, 2004). Much as managers may espouse the safety values associated with a single corporate culture, organisations may consist of many cultures based on professional groupings (Gherardi et al., 1998; Schein, 1996) or other communities of practice (Gherardi & Nicolini, 2000).

The adaptive age requires an acceptance by organisational leaders that groups of workers may, through interaction with one another and the tasks they perform together, create their own shared meanings about what it is to work safely. Under this view that culture is 'socially constructed' (Gherardi & Nicolini, 2000), leaders do not so much hope to engineer a single culture but attempt to understand and influence these differentiated and fragmented cultures such that they are at least aligned with the corporate culture (Martin, 2002). Further, Weick and Sutcliffe (2007) argue that where integrated cultures deny ambiguity, differentiated and fragmented cultures handle ambiguity better, a feature more consistent with High Reliability Organisations. The implication is that the adaptive age requires adaptive cultures.

The notions of an adaptive age and adaptive cultures may also require a change in perspective in relation to the causes of fatalities, injuries and disease and a corresponding implicit awareness of more than one perspective for preventing fatalities injuries and disease. This change in perspective is captured by Hollnagel (2008a) who contrasts two perspectives on safety: theory W and theory Z as shown in Table 1. He argues that to improve safety, a change in perspective is required towards theory Z; a theory that accepts that humans, because of their capacity to adapt to demands, are an asset to the proper functioning of modern organisations.

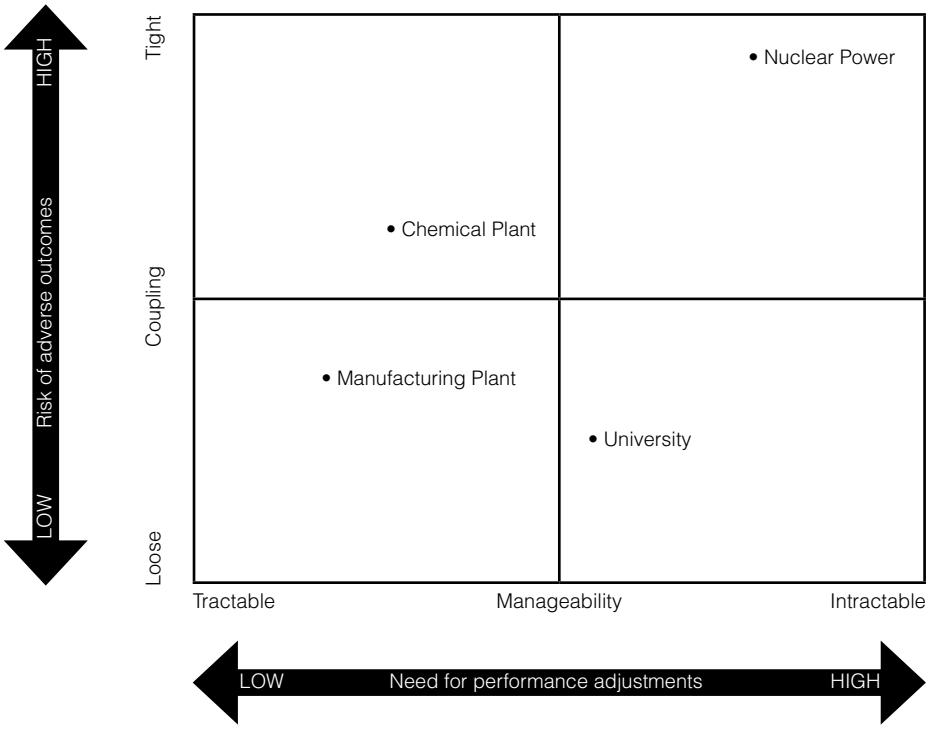
Table 1 Summarising the key perspective changes required in the adaptive age

THEORY W : MANAGERIAL PERSPECTIVE (TECHNOLOGICAL OPTIMISM)	THEORY Z: SYSTEMIC PERSPECTIVE (TECHNOLOGICAL REALISM)
Things go right because people: Systems are well designed and scrupulously maintained Procedures are complete and correct People behave as they are expected to – as they are taught Designers can foresee and anticipate every contingency	Things go right because people: Learn to overcome design flaws and functional glitches Adapt their performance to meet demands Interpret and apply procedures to match conditions Can detect and correct when things go wrong
Humans are a liability and variability is a threat. The purpose of design is to constrain variability, so that efficiency can be maintained.	Humans are an asset without which the proper functioning of modern technological systems would be impossible.

Source: Hollnagel, 2008(b)

However, the need for adaptation is contingent upon an understanding of the complexity of the organisation (socio-technical system) that is being managed. In some organisations (systems), adapting may be a pre-requisite for safe performance whilst in others it may be disastrous. Dekker (2001), for example, makes the point that failing to adapt can be disastrous under certain circumstances and he cites the case of an aircraft which crashed into the sea off the cost of Nova Scotia in 1998. In this case, following procedures for dealing with smoke and fire and not descending too fast, rather than dumping fuel and descending rapidly, led to the plane becoming uncontrollable and crashing into the sea. The dilemma here is that, under certain circumstances, following procedures may result in fatalities and injuries. However, at another time and in a different context, not following procedures may also lead to fatalities and injuries. Thus adaptation is a double-edged sword (Dekker, 2006). This poses a challenge to how we are to think about and action Hollnagel's Theory Z. In the adaptive age, Theory Z does not imply mindless abandonment of procedures, or a "free for all", rather it requires a more demanding standard of attention resulting in a more subtle, nuanced and refined appreciation of how OHS is managed that embodies the capacity to be adaptive rather than rule bound. To better understand this dilemma, Hollnagel (2009a) offers a two dimensional model of performance variability and risk as shown in Figure 1.

Figure 1 Hollnagel's Dimensions of performance variability and risk



The first dimension in Hollnagel's model (Hollnagel, 2009a) is system 'manageability' or controllability. Within tractable systems (simple, stable systems that are easy to control) the need for adaptability is low. By comparison, intractable systems (complex systems subject to change) the need for adaptability is high. The second dimension is coupling (or the degree of inter-dependence between parts of the system). Tightly coupled systems are characterised by more time dependant processes, invariant sequences, little slack and only one way to reach production goals (Perrow, 1999). In tightly coupled systems the risk of adverse outcomes is high. Within loosely coupled systems it is low. This results in four possible ways to characterise an organisation (Hollnagel, 2009a); (i) a ***loosely coupled tractable system*** where the work is routine, requires little in the way of performance variability and any performance variability that is present will have negligible impact upon performance; (ii) a ***loosely coupled intractable system*** is less predictable and the need for performance adjustments will be higher, however, any performance variability will have negligible impact upon performance; (iii) a ***tightly coupled tractable system*** also requires little in the way of performance adjustments; however, performance adaptations that are made and that fail (Dekker, 2003) may quickly result in unwanted consequences because of tight coupling; and (iv) a tightly coupled intractable system may require constant performance adjustments to operate safely.

Therefore the ways of thinking about and approaches to managing OHS must be at least equal to the demands and complexity of the socio-technical system associated with the organisation's activities. If it is decided that the organisation is a tightly coupled, intractable system, for example nuclear power, then a more adaptive response will be necessary. Alternatively, if it is decided that the organisation is a loosely coupled, tractable system, for example, a manufacturing plant, then fewer adaptive responses will be necessary.

BEYOND SAFETY RULES TO COLLECTIVE MINDFULNESS

Safety rules are often written on the basis that greater control of workers' behaviour will not only lead to a safer workplace, but also act as a buffer against prosecution in the case of an accident. However, opinions are emerging that more safety rules and less variability in worker behaviour does not necessarily equate with improved safety performance. In some cases, writing more rules following an incident may lead to conflict between the rule and the actions required to undertake a task (Reason, 1997). Hopkins (2005) prefers to complement safety rules with a strategy of risk-awareness which invites workers "to attend to the risks they face and not simply comply with rules in a mindless fashion" (p. 18). This is supported by examples from industry (Hale et al., 2003; Jeffcott et al., 2006) and by Dekker (2003) who argues that "rather than simply increasing pressure to comply, organisations should invest in their understanding of the gap between procedures and practice, and help develop operators' skill at adapting" (p. 233). He goes on to propose that organisations need to:

> *"(a) Monitor the gap between procedure and practice and try to understand why it exists (and resist trying to close it by simply telling people to comply).*
> *(b) Help people to develop skills to judge when and how to adapt (and resist telling people only that they should follow procedures)" (p. 236).*

This is captured by the term "Collective Mindfulness" that is based on the premise that "unvarying procedures can't handle what they didn't anticipate" (Weick et al., 1999, p. 86). Or to put it another way, variability in human performance enhances safety whilst unvarying performance can undermine safety, particularly in complex socio-technical systems.

In his analyses of the Esso Longford gas plant in Victoria (Hopkins, 2001) and the Gretley mine disaster (Hopkins, 2007) Hopkins is critical of the absence of mindfulness among managers and identifies the need for mindful leadership as one strategy for averting disaster. In his analysis of the BP Texas City explosion Hopkins (2008) discusses how BP had embarked upon a quest to become a High Reliability Organisation (HRO) (to exhibit the characteristics of collective mindfulness) but was largely unsuccessful because they focused on educating front line workers to think differently without instituting the organisational practices necessary to support collective mindfulness.

Effective HROs organise themselves to learn from failure rather than celebrating success (Weick et al., 1999) and give strong responses to weak signals (Weick & Sutcliffe, 2001, p. 4). In short, they are "complex adaptive systems" (Weick et al., 1999, p. 117). HROs are adaptive because; they are 'preoccupied with failure' and treat "any lapse as something wrong with the system" (p. 9); they are 'reluctant to simplify' and strive to simplify less and see more; they are 'sensitive to operations' and encourage situation awareness among front line workers; they have a 'commitment to resilience' and do not allow errors to disable them; and they exhibit 'deference to expertise' and move decision making to those people on the front line with the most expertise.

More recently, Reason (2008) has argued that both individual mindfulness and collective mindfulness are necessary for "maintaining a state of intelligent wariness" (p. 241). This view represents a departure from the view expressed by Weick and Hopkins, a view that emphasises collective mindfulness over individual mindfulness. Reason (2008, p. 31) defends the need for individual mindfulness by posing the question: "If we cannot make systems immune to organisational accidents, what can we do to improve the reliability and error wisdom of those at the sharp end?"

The 'sharp end' refers to any person who is directly interacting with the hazards in a particular context and at a particular time. In essence, it is these people that are the last line of defence between safe and unsafe outcomes. Therefore, providing people at the sharp end with the skills of knowing when to adapt is good for safety and when it could be life-threatening. It may mean complementing safety rules and procedures with what Iszatt-White (2007, p. 452) refers to as "heedfulness". However, workers will need to trust in the "efficacy and applicability" of the safety rules if the rules are to over-ride workers propensity to think that they can work safely without following the safety rules (Iszatt-White, 2007, p. 461). To enhance heedfulness, Iszatt-White (2007, p. 463) argues that "the HRO notions of heedfulness, mutual checking and initiative offer a useful lens through which to consider the shortcomings of rule-based safety approaches". This approach to managing OHS is again indicative that we are entering an adaptive age.

Providing that interventions designed to encourage individual mindfulness or heedfulness are complemented with mindfulness or heedfulness at the organisational level, then it represents a worthwhile step forward particularly if one is to adopt the perspective that variability in performance is better for safety. Individual mindfulness requires workers at the sharp end to have the skills and knowledge to be able to judge when and how to adapt to local circumstances, and when not to adapt, and is consistent with the third HRO principle of being 'sensitive to operations'. Some organisations attempt to achieve this through programs that encourage mindfulness or what Hopkins refers to as "risk-awareness" (Hopkins, 2005) in individual workers. However, Borys (2009) in a study of one program, found that the program was little more than a ritual that focused on completing paperwork rather than an incentive to think carefully about risks. All that it managed to achieve was a culture of completing the paperwork, highlighting the need for organisational practices to work in support of individual mindfulness.

FROM COLLECTIVE MINDFULNESS TO RESILIENCE ENGINEERING

Contemporary approaches to safety have attempted to establish safe systems and ensure that managers and workers work inside the boundaries of those safety systems (Woods & Hollnagel, 2006). Thus it is assumed that constraining human performance is essential for safety. An alternative paradigm that is emerging is that safety is achieved by managers and workers adapting to changing circumstances. In this case, it is the variability in human performance, relative to the situation, that is essential for safety. Although this paradigm emphasises adaptive practices, these practices are designed to complement not replace good safe design principles whilst acknowledging that complex socio-technical systems will always present opportunities for surprise. Therefore, under this alternative paradigm, safety is understood as a "characteristic of how a system performs" (Woods & Hollnagel, 2006, p. 347) and that resilience is a quality that emerges from the functioning of the system. Resilience engineering subscribes to this alternative paradigm and in doing so, is similar to collective mindfulness and heedfulness as all three concepts focus on the importance of performance variability for safety. However, what sets resilience engineering apart from collective mindfulness is the focus on learning from successful performance as well as unsuccessful performance (Hollnagel, 2008c, 2009b) i.e. why things go right and as well as why things go wrong. The rationale for this perspective is that failures and successes result from the same underlying processes (Hollnagel, 2009b). Hollnagel (2008b) argues that "it is necessary to study both successes and failures and to find ways to reinforce the variability that lead to successes as well as dampen the variability that leads to adverse outcomes" (p. xii). Thus Hollnagel (2009b, p. 117) states:

> *A resilient system is able effectively to adjust its functioning prior to, during, or following changes and disturbances, so that it can continue to perform as required after a disruption or a major mishap, and in the presence of continuous stresses.*

Resilience engineering research has focussed on intractable and tightly coupled systems such as air traffic control centres and hospital emergency departments and led researchers to identify a range of markers of resilience. While there is no agreement on these, one marker that has been referred to repeatedly in the resilience engineering literature is the gap between work as imagined and work as actually done (Dekker, 2006; Dekker & Suparamaniam, 2005). One reason for the widening of this 'gap' is a phenomenon known as "practical drift" (Snook, 2000).

Practical drift refers to a situation where, over time, local work practices 'drift' away from the original intent at the time of system design, to more locally efficient work practices. However, if the local practices drift unnoticed and the degree of coupling in the system switches from loose to tight coupling, for example, circumstances may change resulting in functions becoming more time dependant (Perrow, 1999) without a corresponding change in local practices from task to rule focused, then the results can be catastrophic. Such was the case in the friendly fire shoot down of a Blackhawk helicopter over northern Iraq in 1994 (Snook, 2000). In this case, crews were struggling to make sense of their situation and in the time available, failed to do so. Each level of the system, individual, group and organisational, failed to identify that local practice had uncoupled from the written procedures. When there is slack in the system, this is seen as being efficient, but when circumstances change and revert to being tightly coupled and time dependant, like when attempting to identify if the helicopters below you are friend or foe, then the resultant decisions can be deadly. The adaptive age demands that people at all levels of the organisation need to be able to distinguish between drift that is adaptive and improves organisational performance

and drift that becomes dangerous.

The solution to drift is not attempting to further restrict performance variability as this simply sets up a new cycle of practical drift. Rather, it is more appropriate to monitor and detect drift toward failure and attempt to estimate the distance "between operations as they really go on, and operations as they are imagined in the minds of managers and rule-makers" (Dekker, 2006, p. 78).

Therefore "drift into failure" can be used as a metaphor for organisations wishing to become more resilient. For organisations this may mean making the gap between work as imagined and work as actually performed visible because the more the gap remains hidden, the more likely it is that the organisation will drift into failure. In fact Dekker and Suparamanian (2005) go so far as to say that the larger the gap "the less likely that people in decision-making positions are well calibrated to the actual risks and problems facing their operation" (p. 3).

CONCLUSION

As the limitations of OHSMS and safety rules that attempt to control behaviour are becoming evident, it is time to consider that we are moving into a fifth age of safety, the 'adaptive age'; an age which transcends rather than replaces the other ages of safety, ages which include the dominant safety paradigm that assumes that safety is achieved by establishing safe systems and ensuring that managers and workers work inside the boundaries of those safety systems.

The adaptive age challenges the view of an organisational safety culture and instead recognises the existence of socially constructed sub-cultures. The adaptive age embraces adaptive cultures and resilience engineering and requires a change in perspective from human variability as a liability and in need of control, to human variability as an asset and important for safety. In the adaptive age learning from successful performance variability is as important as learning from failure.

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