Human Factors in Accidents

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Introduction

Many organisations spend a lot of time and effort trying to improve safety. As well as addressing technical and hardware issues, many conduct safety management system audits to discover deviations from the performance standards set in their Health & Safety Policies. Line-management is encouraged to conduct regular inspections of the workplace and employees are trained to behave safely and are given the appropriate protective equipment. The impact of such initiatives could be seen in the overall downward trend in accident statistics from 1990 to 1998/99. Over the last two years, however, accident statistics are rising in many UK industrial sectors. In the Quarry Industry, for example, there has been a 60% rise in the number of fatalities (HSC, 2001). We need to ponder why this is happening at a time when the industry is focusing its efforts at revitalising Health & Safety to create a positive safety culture.

Safety Culture

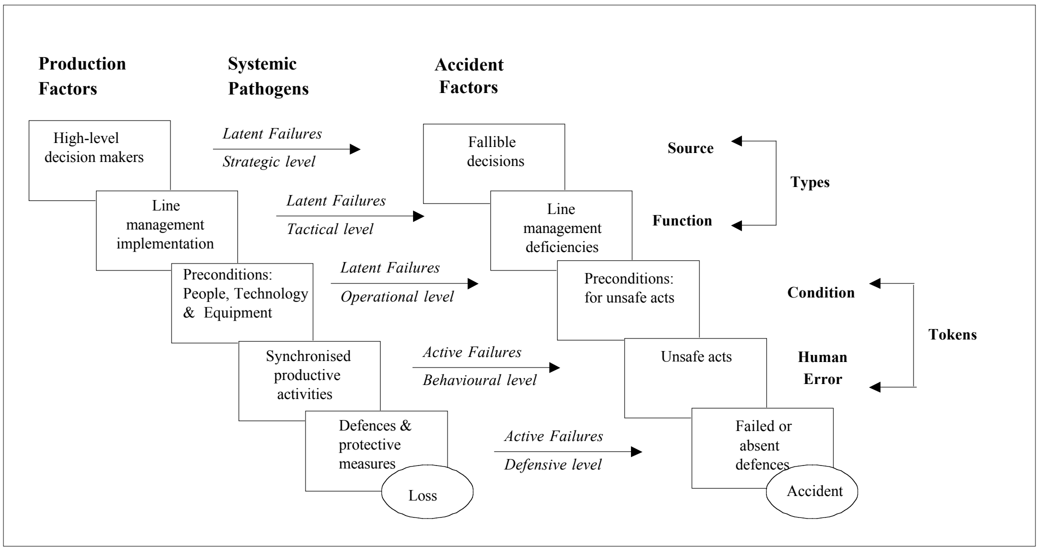
Gaining international currency over the last decade, the term 'Safety Culture' is loosely used to describe the corporate atmosphere or culture in which safety is understood to be, and is accepted as, the number one priority (Cullen, 1990). Unless safety is *the* dominating characteristic of corporate culture, which arguably it should be in high-risk industries, safety culture is a sub-component of corporate culture, which alludes to individual, job, and organizational features that affect and influence health & safety. As such the dominant corporate culture *and* the prevailing context such as downsizing, organizational restructuring (e.g. Pierce, 1998) will exert a considerable influence on its development and vice-versa as both inter-relate and reinforce each other (e.g. Williams, 1991). This illustrates that safety culture does not operate in a vacuum: It affects, and in turn is affected by, other operational processes, organizational systems and/or societal events (Cooper *et al,* 1994, Pidgeon, 1998). By way of example, top-level decision-makers have to deal with external influences (e.g. excessive aggregate taxes) if they are to steer their organisations to success. Although a 50% increase in safety performance can lead to a 12% increase in productivity (Stewart & Townsend, 2000) many company's narrowly concentrate on economic factors (e.g. Cost control, Increased production targets, Downsizing, Mergers & Acquisitions) in attempts to overcome the factors creating the adverse economic climate. Ironically, this can lead to the inadvertent introduction of accident causing 'pathogens' into the organisation, resulting in an increased incident/accident rate, which in turn increases costs and reduces production.

Accident Causation Chains

This becomes more apparent when theoretical models of accident causation are examined (See Cooper 2001b for a detailed overview). The most influential of these is Heinrich's Domino model (See Heinrich *et al.* 1980; Weaver, 1971; Adams, 1976 ; Reason, 1990). While Heinrich concluded that the key domino was that pertaining to unsafe acts, Weaver (1971) focused on symptoms of operational error (management omissions) that interact with unsafe acts and/or conditions. Adams (1976) emphasised that operational errors were caused by the Management structure; Management's objectives; the Synchronisation of the workflow system; and How operations were planned and executed. In turn these operational errors caused 'tactical errors' (unsafe acts or conditions). Reason (1990) also shifts the main focus of accident prevention away from unsafe acts and more onto the organization's management systems. In conjunction with John Wreathall, Reason (1993) aligned Heinrich's domino model with a parallel five element production model and identified how and where latent and active safety failures (termed "*pathogens* ') might be introduced into organizational systems (See figure 1). Reason asserts that both latent and active failures are introduced by organisational or managerial factors (e.g. top-level decision-making), but individuals (e.g. psychological or behavioral precursors) trigger the active failures.

The evidence supporting these assertions is overwhelming and is drawn from a diverse range of industrial sectors such as commercial aviation, nuclear power generation, process plants, railways, marine operations, financial services and healthcare institutions (Reason, 1998). Support can also be drawn from the quarrying industry. For example, in the UK, quarries are often hampered by a lack of space imposed by population density, housing and roads. Because of this it is often very difficult to achieve ideal road layouts, in terms of gradients, road widths, cambers, escape roads, etc., (*latent failures*). Equally, this causes other difficulties for site managers to ensure that vehicles and pedestrians are kept clear of operational areas, while traffic congestion is kept to the absolute minimum. However, despite these difficulties, many companies continue to attempt to maximise cost/benefit ratios, by using extremely large vehicles, often with payloads anywhere between 50 - 100 tonnes. Unfortunately as they need a lot of space to manoeuvre safely these vehicles are often unsuitable for the prevailing conditions (*latent failure*).

Figure 1: Adaptation of Reason & Wreathall's pathogen model



In addition, these larger vehicles tend to have a much greater number of driver 'blind spots', particularly at the rear (*latent failure*). Thus the choice of vehicle, for the space available can inadvertently introduce a number of latent failures or 'pathogens'. Should the driver of such a vehicle attempt to manoeuvre in reverse without visual aids or a 'traffic controller' (*an active failure*), relying instead solely on automatic reversing audible and visual alerting signals, the drivers' actions and the pathogens (size of vehicle and blind spots) could combine to trigger an accident: Either colliding with another vehicle or fatally injuring a pedestrian. Just to show the problems faced by drivers of such vehicles***, can you see the person standing next to the white truck in the round mirror in the picture below?***

Figure 2: Drivers view from the cab of a large vehicle

The photo example also illustrates a further aspect of human factors in accidents that reflects the concept of safety culture, and that is the relationship between people's perceptions of the situation and the influences of these on their subsequent behaviour. I do not know about you, but I could not see the person standing by the white vehicle. As such, as the driver I would continue to reverse (*behaviour*) in the belief (*perception*) that it was safe to do so

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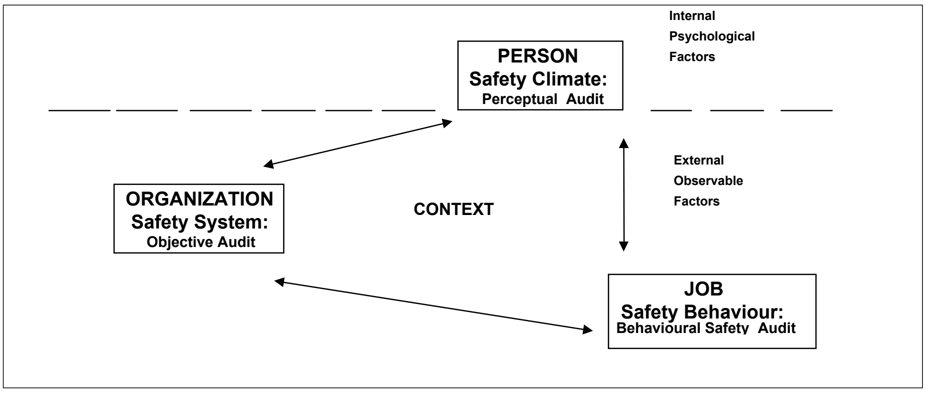
(*situation*). Cooper (2000) asserts that by examining the reciprocal interactions between these human factors via safety management system audits (*Situational*), safety climate surveys (*perceptual)* and behavioural safety systems (*behavioural)* it is possible to measure safety culture in a meaningful way at many different organizational levels (See Cooper, 2002).

Figure 3: Cooper's Reciprocal Safety Culture Model



The model predicts that improvement interventions aimed at any one of these components will exert a reciprocal effect on the other two while also recognising that this influence may or may not occur simultaneously. In other words, a change in people's safety behaviour *will* exert an effect on their attitudes and beliefs about safety and change elements of the company's safety management system *but* it may take time.

Cooper also posits that the outcome measure (*product*) of a positive safety culture is a collective behavioural commitment to improving safety that can be seen at every level of the organisation, all of the time. This was encapsulated in his definition of the safety culture product as *"that observable degree of effort by which all organisational members direct their attentions and actions towards the improvement of safety on a daily basis*" If the organisational membership cannot be seen directing their attention and actions towards improving safety (e.g. ladders not being tied off and no guard-rails on leading edges) it could be argued that there is not a culture of safety in that company or at that site (see figure 4).

Figure 4: Death of a foreman with 10 years experience in quarries (Jan 2002)

Thus, the degree to which the safety culture is positive or negative will depend *entirely* upon the collective amount of energy *visibly* expended in the pursuit of safety excellence by organisational members. God forbid, was figure 4 representative of the whole quarrying industry! Otherwise, it could have been stated quite categorically that the quarrying industry does not possess a collective behavioural commitment to safety, and that is why the fatal accident rate is rising!

Byrom (Cited in Cooper 2002) defined a classification of risk behaviour types that could comprise a common measure of '*that observable degree of effort...*' (see table 1) across all types of industry. The organisation could 'observe' the effort by which all organisational members try to reduce the 'risk producing' behaviours and increase the mitigating, procedural, supportive and leadership behaviours. Scores for each of these behavioural types could be combined to assess ' that observable degree of effort…..".

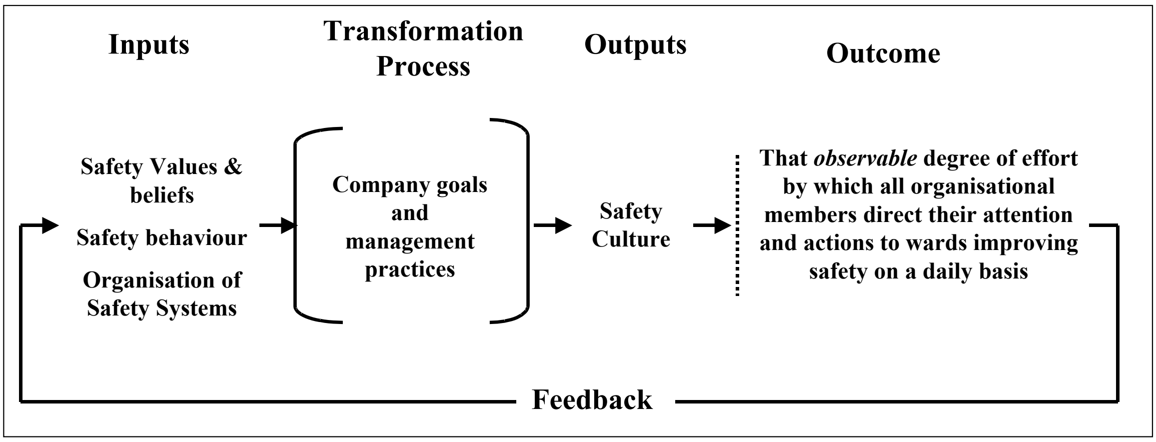
Table 1: Classification of Risk Behaviour Types

Behaviour Type	Examples
Risk Producing	Lifting incorrectly; Driving too fast
Mitigating or Alleviating	Wearing PPE
Procedural (Risk Control Systems)	Following explosion size controls
Supportive (SMS Systems)	Reporting Accidents / Incidents
Safety Leadership	Acknowledging safe behaviour

Use of such a classification system could also help to deliver managerial accountability for safety as those things that management actually do in relation to safety can be monitored at all organisational levels. Individual manager's performance could then be used in annual performance appraisals (Cooper, 2001a). The general lack of accountability is safety's 'Achilles Heel' and is one possible reason for the rising accident rate of late. More often than not, managers are being held accountable for their financial and production performance, but not for safety.

The Business Process model of Safety Culture (see figure 5) illustrates the broad attributes that comprise Cooper's safety culture construct (i.e. Inputs) are processed by a combination of the company's goals and management practices and transformed into the safety culture (i.e. Output) to create the safety culture product (i.e. Outcome). This process model makes it very clear that it is the company's goals and how a company manages the safety 'Inputs" that determines the degree to which people commit themselves to safety. This means that companies must ask themselves very searching questions about the best ways to manage safety so that people will direct their attention and actions towards the improvement of safety on a daily basis. Peterson (1998) argues that managerial accountability is the key, whereas Brown (1997) indicates that a genuine participative 'safety partnership' between management and the workforce is required. I would argue that both are as equally important as the other, whereby *everybody* is held accountable for safety with no exceptions.

Figure 5: Business Process Model of Safety Culture (Cooper, 2002)



Delivering a Safety Partnership

The creation of a genuine safety partnership between employees and management is a relatively simple thing to achieve. In essence it means that safety must be done *with* people, not done *at* people. One of the major aspects of safety culture discussed above was its emphasis on the *observable* aspects (i.e. behaviours) of what people actually do on a daily basis *at every level of an organisation.* The classification of behaviour types also provides us with the means to develop behavioural measures, with which to assess "that observable degree of effort….", at each level of the organisation. In essence we are talking about the implementation of behavioural safety at all levels of the

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organisation where safety related behaviour becomes the unit of measurement. This offers the advantage of other safety-related issues in the accident causal chain being identified and dealt with before an incident occurs, ensuring that a company becomes pro-active in its approach to safety.

Because 'safety behaviour' is the unit of measurement, a collaborative, problem-solving approach involving both management and employees is crucial if you are to identify critical sets of safe and unsafe behaviours that are used to develop 'Safety Behaviour Measures'. These imeasures provide the basis for personnel to systematically monitor and observe their colleague's and / or their own, ongoing safety behaviour, in an enabling atmosphere (See Cooper, 1994). At the workgroup level, based on the results of the peer monitoring for a certain time period, the workforce set their own 'safety improvement' targets to be achieved within a five to six month period. Information feedback is provided on a weekly basis during this period to allow the workgroups to track their progress in reaching the safety improvement targets (See Cooper, 1993). This cycle of events is repeated every five to six months so that the behavioural inventories reflect new sets of safety behaviours, and the improvement targets get progressively harder. In this way the process is continually refreshed and stretched.

At the front-line, middle and senior management levels, behavioural safety leadership indices are also developed by a consensual problem-solving approach, whereby the safety leadership behaviours expected from each level of management are defined. These are then turned into safety leadership inventories and management monitor themselves against them on a weekly basis. Targets are then set by the different levels of management as to the levels of safety leadership they envisage exhibiting on a weekly basis. Feedback is obtained on a monthly basis so that adjustments can be made if necessary. The data from such monitoring could and should be used in annual performance appraisals to the extent that career progress and raises in salaries and benefits are dependent to some degree upon the individual's positive contribution towards the company's safety performance. The most senior management team should also monitor progress on a monthly basis, in terms of the percentage safe score being achieved by individual sites, the levels of leadership being exhibited by all levels of management and the number of remedial actions being completed.

Typically, companies adopting this approach become proactive safety managers, which are usually rewarded by less accidents, consistent safety management, better communications and greater involvement in team-working, all of which exert beneficial effects on production related issues and bottom line profits. However, it is not a journey you want to begin if you do not intend doing things properly. You will soon be found wanting and your employees will never trust you again when it comes to safety. This lack of trust could spill over into other areas of functioning.

Does it work?

Because the behavioural approach differs considerably from traditional ways of improving safety, a question commonly asked is 'Do these ideas work in practice?' Overwhelmingly, the answer is yes! Psychologists from around the globe have consistently reported positive changes in both safety behaviour and accident rates, regardless of the industrial sector or company size. These include studies conducted in Construction, Mining, Engineering, Food processing, Manufacturing, Shipbuilding and Offshore installations (See references on www.behavioural-safety.com) Typical findings include:

Organisational Features

- Improved levels of safety performance;
- Reductions in accident rates;
- Significant reductions in accident costs;
- Improvements in co-operation, involvement and communications between management and the workforce;
- Improvements in Safety Climate;
- Ongoing improvements to Safety Management Systems

Person features

- Greater 'ownership' of safety by the workforce;
- Improved levels of safety behaviour and attitudes towards safety;
- Greater individual acceptance of responsibility for safety.

Summary & Discussion

In the short time available I have attempted to give you a short tour of the Human Factor in accidents. I have tried to cover the concept of safety culture, the broad attributes that comprise a safety culture and the ways of measuring it. I have tried to show you how accident causing factors are introduced into organisations and how they lie dormant waiting for the unwary to trigger off a chain of events that leads to an accident. I have also tried to give you a practical route map forwards in relation to implementing behavioural safety and developing a positive safety partnership. Only you can judge how well I succeeded.

So now let us ponder why it is that the fatality rate in the industry is increasing sharply, at a time when there is a positive focus on Health & Safety and Industry wide accident reduction targets have been set. We could speculate that the extremely high level of aggregate tax imposed by the government is leading to cost reduction exercises, higher production targets and job insecurity? In turn, these factors are impacting on people's behaviour at all different hierarchical levels throughout the industry, the outcome of which is a sharply increased accident/incident rate? Such speculation would certainly fit with theory and evidence relating to the human factor in accidents. Regardless of how compelling this argument might be, however, it should not be used as an excuse that allows the industry to abrogate its safety responsibilities.

If we ponder on the industries own behaviour, we might speculate that the industry is not holding people accountable for safety performance in the same way as people are being held accountable for production and financial issues. In turn, this is weakening the overall collective commitment to safety. We might even speculate that despite the participation provisions contained in The Quarries Regulations 1999 a true genuine safety partnership between management and the workforce has not yet been achieved. Rather safety is still being done *at* people, not *with* people. As such, safety is still associated with negative consequences and people only take part because 'they have to' not because they want to. Alternatively, we might speculate that actions are not matching rhetoric and this is undermining the whole notion of commitment to safety simply because when it comes to it, safety is not seen to be important enough. I do not know the true answer.

What I do know is that unless the industry seriously examines what it is *actually doing* in relation to safety, and starts to measure and monitor peoples safety behaviour at *every hierarchical level*, then many more people are going to die in UK quarries. God forbid that you, the reader, have to look the widow in the eye to explain!

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