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Safety – behaviour and culture in construction

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Abstract The construction industry has a poor safety record. There is a common perception that this is because it is an inherently dangerous industry. It is suggested that the industry would be better characterized as one with a poor safety culture and that attempts to improve the safety record will not be fully effective until the safety culture is improved. The relationship between unsafe behaviour and safety culture is discussed together with the difficulties of assessing and managing safety culture. Some of the influences on safety culture in construction are described. The initiative to develop an improvement in the safety culture of construction needs to come from within the industry through a genuine commitment to safety.

Keywords *construction, hazard, safety culture, unsafe behaviour*

INTRODUCTION

Construction has one of the worst records of industrial safety. Statistics produced annually by the Health and Safety Executive (e.g. HSC 1989/90), indicate that fatality and major injury rates in construction are high (Table 1).

More recent figures show an improvement but they are still high with fatality and major injury rates estimated at, respectively, 7.5 and 241 per 100 000 employees (HSC 1992/93). The human suffering alone is sufficient to demonstrate the need for improvement but accidents also incur enormous costs. For example, a carefully worked case study of accidents on a particular construction site (HSE 1993)

Table 1 Fatal and major injury rates per 100 000 employees

	1981	1982	1983	1984	1985	1986/7	1987/8	1988/9	1989/90
Fatal injury									
Construction	9.7	9.7	11.6	9.8	10.5	10.2	10.3	9.9	9.2
Manufacturing	2.0	2.4	2.2	2.7	2.4	2.1	1.9	1.8	2.0
Major injury									
Construction	155.6	188.5	213.2	225.2	225.8	282.7	276.5	285.9	306.9
Manufacturing	68.8	72.3	79.6	89.6	92.3	145.0	142.0	143.7	141.1

showed that accident costs represented 8.5% of the tender price, (£700 000 of an £8m tender price). Although part of a study of five different industrial organizations the evidence is strong that a similar pattern is repeated across the UK (HSE 1993).

In the following discussion, based on research by Dester (1993), it is suggested that poor safety culture is a significant factor in the poor safety record of the construction industry and that unsafe behaviour is a feature of this culture. It is suggested that audits of unsafe acts can be adapted to provide a credible means of safety culture assessment in a labour intensive industry such as construction. A detailed analysis of audits can demonstrate the extent of a poor safety culture as well as help decide appropriate corrective action. This discussion is not a review of safety culture or methods of assessment. Nor are legislative or regulatory measures examined.

THE 'DANGERS' IN CONSTRUCTION

Is the accident rate in construction high simply because construction is inherently more dangerous than other industries? Davies & Tomasin (1990) state that the reasons for this poor safety performance are the short term and transitory nature of the industry, the lack of a controlled working environment and the complexity and diversity of size of organizations within the industry. It is the first author's view, based on 20 years' experience in contracting, that the perception is widespread that there are inherent 'reasons' for the high accident rate. This view has been reinforced through research involving a programme of semi-structured interviews with safety practitioners with experience of safety management in various industries, including construction, chemical, off-shore and mining, (Dester 1993).

Safety is freedom from danger. It is argued here that these special 'reasons' are indeed inherent but if they are viewed as hazards to be managed within a positive safety culture the safety record could be much improved. A hazard is defined here as a set of preconditions for failure (Blockley 1992).

SAFETY CULTURE

Poor safety culture is now being recognized as a significant factor in the development of accidents and disaster. The CBI (1990) also linked a good safety culture with profitability. Safety culture was defined as 'the ideas and beliefs that all members of an organization share about risk, accidents and ill health'. Butler (1989) described the need for a fundamental change in corporate culture with regard to safety. Heiermann (1988) suggested that employers need actively to develop safety consciousness which he defined as 'the preparedness and capability of recognizing danger, estimating the likelihood of an accident happening, and its extent, and acting correspondingly'. Steiner (1987) referred to safety climate as 'intangible safety attitudes and perceptions' while describing a means for its assessment. Here, safety culture is defined as the set of beliefs, norms, attitudes, roles, and social and technical practices which are concerned with minimizing the

exposure of individuals, within and beyond an organization, to conditions considered dangerous or injurious (Pidgeon *et al.* 1991). Since safety is part of quality (Blockley 1992) these ideas are closely linked with quality culture and management and hence directly with profitability and success.

'Much social learning occurs on the basis of casual or directed observation of behaviour as it is performed by others in everyday situations' (Bandura 1977). Very often, unsafe behaviour which is one manifestation of poor safety culture, does not result in an accident. Therefore, a poor safety culture results in behaviour that influences and reinforces its own perpetuation.

Unsafe behaviour is a major feature of accidents. Heinrich *et al.* (1980), for example, suggested that about 90% of industrial accidents involve unsafe acts. This does not mean unsafe behaviour is the cause of 90% of accidents, rather it is one of a number of contributing factors and very often it is the final 'trigger' event. Kletz (1988) described some underlying causes which were often management related. Reason (1990) referred to latent errors that lie dormant only to interact later with other factors to produce an accident. In Turner's (1978) representation of disaster, conditions such as poor management and lack of knowledge incubate into disaster. These conditions are hazards which may set off the incubation of other hazards which in turn may incubate yet more hazards and so on until a precipitating event triggers a disaster. Viewed from this perspective, a hazard is defined as an incubating set of preconditions for failure, and a hazard event is the final event that triggers an accident or failure. Thus, for example, behaviour, management processes, technical difficulties, safety culture and social factors may all, in certain circumstances, be hazards.

The net effect of this incubating process is an increasingly serious set of hazards described by Blockley (1992) as the hazard content of a project or 'proneness to failure'. A model of hazards has been derived by Dester (1993) and described by Dester & Blockley (1994). It consists of a large set of hierarchically structured propositions which may be used to accumulate evidence of proneness to failure to different levels of precision of description as thought appropriate in any particular test. A small part of the model is shown in Fig. 1, although this figure does not in any way indicate the full extent, scope and scale of the hierarchy which in its present form contains over 50 000 components. One important element of the model is safety culture.

If the effort to prevent accidents is directed only at the 'trigger' hazard events, it is often directed at the behaviour of the manual workforce. This is an implicit assumption that it is they who are at fault. However, working practices are influenced by the requirements, demands and expectations of clients, designers, consultants, and managers. It is also likely that the beliefs, attitudes and behaviour of construction managers, designers, consultants, educationalists, researchers and clients are reflected in the beliefs, attitudes and behaviour of construction workers. Certainly, Hinze & Parker (1978), following an investigation of construction work practices, suggested that good safety performance and high productivity are linked to management styles. They also concluded that excessive pressures by company

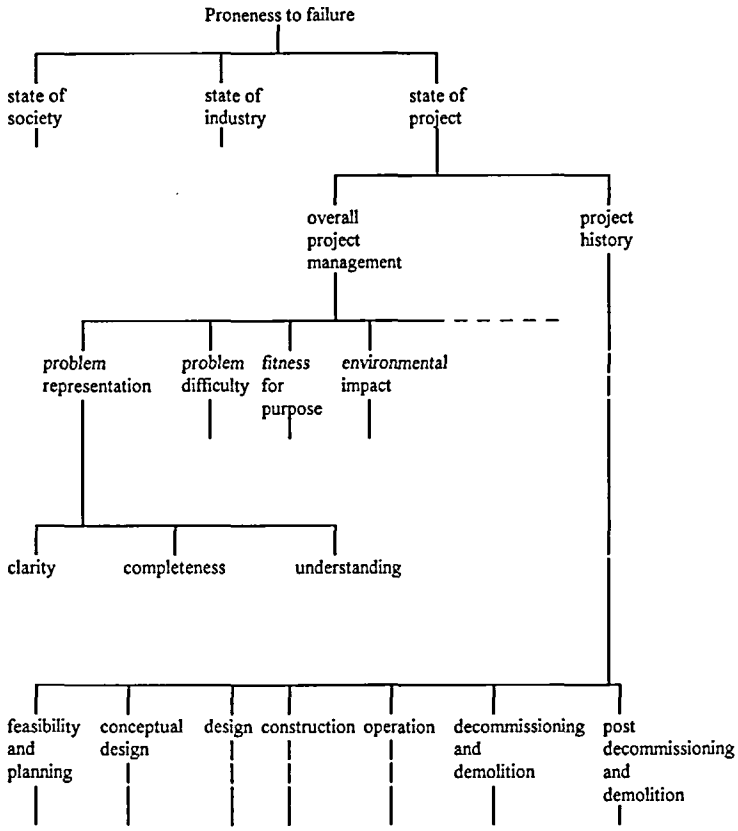

Figure 1 Illustration of the proneness to failure hierarchy.

head offices on site superintendents and by superintendents on the labour force were likely to increase injury frequency and reduce production. Similarly Kletz (1988, 1990) stressed the effect of management practices in accidents which initially may seem to be the result of poor work practices at an operational level. It is reasonable to suggest that management practices, including lack of leadership, commitment and action, are management manifestations of unsafe behaviour. The leaders and representatives of sectors of the construction industry have considerable responsibility for the state of the industry. Recent publications, CIRIA (1994), HSE (1994) and ICE (1993), are to be welcomed in this regard.

The perception of danger, whether or not misconceived, can encourage the development of a good safety culture. High risk technology companies such as Nuclear Electric, Du Pont and a number of oil companies do not simply react to imposed safety requirements, rather they actively strive to exceed them and to carry out research and investigations to improve current practices.

The hypothesis advanced in this paper, based on the research of Dester (1993), is that in order to improve the safety record of the construction industry it would be better to characterize the industry as one with a poor safety culture rather than

one which is inherently dangerous. In order to test this hypothesis it is necessary to develop ways of assessing safety culture and to monitor the changes that occur.

Assessment of safety culture

An audit is defined here as a formal, systematic, critical examination. Hazard auditing is the use of audits for the identification of hazards. Auditing informs action to reduce or eliminate particular identified hazards. Unsafe behaviour is one type of hazard and audits of unsafe acts are a means of encouraging safer behaviour.

Continual monitoring of behaviour on a construction site, followed by the necessary corrective action, is often impracticable and perhaps, on occasions, even impossible. In a poor safety culture there will be a lack of will and motivation to improve safety performance, and corrective action will be seen as an inconvenience. Audit observations are discrete and, although they clearly apply at the time of an audit, the continual changes of process may invalidate them. The argument is simply, 'What is the point in making the effort to correct a situation that is about to change anyway?' In effect the assertion is that the total hazard content remains unchanged since even if specific instances of unsafe behaviour can be corrected other different types of unsafe act will still be incubated.

The Du Pont Company, which has a good reputation for safety performance (Kletz 1990), advocates unsafe act auditing (Monk 1988). Within a good safety culture an unsafe act audit-corrective action procedure can be part of a learning process where memories are constantly being jogged and understanding reinforced and improved. Nevertheless the auditing of an abstract concept, such as safety culture, is problematic. Kletz (1990), for example, has expressed reservations about whether attitudes, which are a part of culture, can or should be directly dealt with by a hazard management system. Of course safety culture is more than a matter of attitudes. It concerns the beliefs and practices which are firmly established characteristics that can be identified and improved through learning (Turner 1992). In order to deal with safety culture, audits of unsafe acts have to be designed and used in a way that goes beyond the straightforward audit-corrective action process. The focus has to be on audits of hazards (the incubating pre-conditions to an accident or failure) rather than the more easily recognized trigger accidents or hazard events.

Another potential difficulty is that of risk homeostasis, whereby risk behaviour alters with circumstances to keep risk levels sensibly constant (Wilde 1982; Mckenna 1987; Adams 1988). However, if the lowering of direct target levels of hazard (and hence indirectly target levels of risk) is an integral part of a hazard management system, then this becomes less significant. The ethical issue of whether or not a person should actively try to change another's culture is a separate issue and outside the scope of this discussion. The premise here is that every possible means should be adopted to improve safety performance in the construction industry.

Thus the use of unsafe act audits to provide evidence about safety culture is quite different from that of a 'straightforward' unsafe act audit since the objectives are different. A straightforward unsafe act audit is one in which the objective is simply to attempt to correct observed unsafe behaviour. The term 'straightforward' is not intended to imply any degree of significance, importance, quality or expertise.

In an audit of unsafe acts which attempts to provide evidence about safety culture there is a requirement for:

- A detailed analysis of observed unsafe behaviours as they incubate
- A judgement and interpretation of this analysis with respect to deficiencies in safety culture
- An identification of where these deficiencies lie
- A continuing comparison of separate audits, analyses, judgements and interpretations.

Thus, the direct changing of behaviour with respect to the trigger hazard is not the primary purpose. Rather the objective is to change beliefs and practices through education and training. Of course, these two forms of unsafe act audit are not mutually exclusive.

A single set of observations per audit is not sufficient as an indicator of safety culture. Rather, a series of sets of observations will be needed which take into account the time and periods of observations and the type and relative intensity of the activities being audited. The development of an audit is achieved through a recursive, reflective thinking type process (Blockley 1992) that integrates prior knowledge, perceptions and expertise with the lessons learned during the development period. As knowledge and understanding about safety culture develop, so standards for assessment will continually develop.

Dester (1993) proposed that another indicator of safety culture could be an assessment of 'the value of a belief' about safety provision. Beliefs about safety in its different forms (e.g. structural, occupational, environmental) could be compared with beliefs about profitability and other features such as functionality and degree of excellence. The credibility of this approach could only be established through experience and the knowledge, expertise and development of standards that this would bring. The problem is further complicated by the way individuals interpret their own beliefs or those they ascribe to their organization.

Another possible indicator concerning safety culture is whether sufficient resources (material, human and time) are allocated to safety (Dester 1993). For example, when resources are concentrated on factors other than safety, there is evidence of a poor safety culture. However, a low allocation of resources to safety within an extremely tight budget is not necessary evidence of a poor safety culture if in fact it is better resourced than other project activities. It can also be difficult to distinguish between resources allocated specifically to safety and the basic requirements of production. The use of temporary works in construction is an example.

Clearly, therefore, the assessment of safety culture is not trivial and cannot be

reduced to simple terms. The relative significance of the different indicators of safety culture is context dependent. It is necessary to establish a system of assessment that combines the three elements of unsafe behaviour, value of belief and resources allocated. The nature of that combination will depend upon the industry or the process being examined. For construction, it is suggested that 'unsafe behaviour' is the most significant indicator and provides the strongest evidence of poor safety culture.

IMPROVING THE SAFETY CULTURE OF CONSTRUCTION

Lack of desire and motivation about safety is a feature of poor safety culture. Since feedback tends to reinforce views, positive improvements are difficult to make because they are not seen as important.

Outside pressure on the construction industry to operate safely is not as great as on high risk industries. For example, there is relatively little publicity about the industry's poor safety record. Of course a major disaster, irrespective of industry, will always attract attention. The publicity surrounding these rare events will produce public pressure but its effect will depend upon the extent to which society, as a whole, appears to be affected. Except for major events, such as the tunnel collapse at Heathrow (NCE 1994), construction accidents are not usually newsworthy since they tend to be localized and to involve small numbers of people. This is in contrast to airline crashes, radiation leaks from nuclear plants, and unpredicted consequences of drugs use in medicine.

A more direct pressure on industrial safety is the potential loss of production and business. The fear of damage to profitability can be a big incentive to increase safety effort (Butler 1989; Fido & Wood 1989; CBI 1990). Accidents in a manufacturing or process plant can have a considerable effect on output. The potential for large consequential losses is a powerful incentive to try and avoid accidents. In construction, despite an observed high ratio of uninsured losses to insured losses (HSE 1993), the magnitude of such losses can seem insignificant when compared to the magnitude of losses in other industries. Leopold & Leonard (1987) suggest that insurance costs can only be influenced, significantly, by the largest contractors. If this is the case, there would appear to be little financial incentive for many contractors to attempt to reduce their insurance costs by improving safety performance. It will be judged an unreasonable risk to tender for work on the presumption that increased safety costs will reduce overall costs. This might seem particularly so if other business competitors appear prepared to go along with the *status quo*. Without a genuine belief in the hypothesis that increased safety effort leads to increased productivity and profitability, any safety improvements are likely to be at best gradual and at worst non-existent.

Without significant pressure from society or demonstrably clear commercial benefit, the main impetus to improve safety effort in construction has to come from within the industry. A genuine commitment to safety provision requires that construction company management has the requisite moral convictions and

beliefs in a moral accountability for safety, and believes that management actions can influence safety behaviour at site level. Again this is difficult to initiate within a poor safety culture. Those individuals and organizations that do have a good safety culture have to provide the impetus for safety culture development. The objective is to overcome what Booth & Lee (1993) describe as cynicism about commitment to safety.

Clients can apply positive pressures to improve safety culture. In particular those associated with industries having a better safety culture, most notably the nuclear and chemical process industries, can and often do insist that contractors are expected to comply with the work practices of those industries.

Within the industry consulting engineers can develop better design techniques for safety. Examples of good safe structural design practice can be disseminated (SCOSS 1994). The construction processes can be re-engineered for safety. Supervision of construction and liaison with clients can be improved. Obviously, contractors with a good safety culture are well placed to exercise influence. Teaching institutions can make students aware of the issues.

Companies influence safety culture through resource power (Handy 1985). In construction they are able to exert influence as separate organizations and collectively through their own representative bodies such as the Federation of Civil Engineering Contractors and through the professional institutions. Companies with a good safety culture will have a balanced set of priorities linking safety provision and commercial viability. In a poor safety culture management can be indifferent, cynical, or even occasionally hostile to the better provision of safety (Booth & Lee 1993) and this undermines the commitment of others. This suggests that companies with a good safety culture have a duty to look outside their own organization and take an active lead in promoting safety commitment throughout the industry. Professional institutions are particularly important since many of the individuals with the greatest influence in professional bodies are in senior company management positions. Professional bodies are able to represent a collective view that may not correspond with collective company interests. Conversely, collective company views can affect the policies of professional bodies.

Clearly one means of exerting external pressure on the industry is through tighter regulations and legal enforcement. Although, as stated earlier, it is not the purpose of this paper to review recent legislation, these changes do put companies under pressure. However, it is not clear that changes in the law necessarily produce corresponding improvements in behaviour and this remains an issue for further investigation.

CONCLUSIONS

The perception of construction as an inherently dangerous industry tends to inhibit the much needed improvement in safety performance. Attention should rather be focused on the poor safety culture of the industry.

'Incubating' hazards should be identified and managed. One such hazard is

poor safety culture. Other hazards are, for example, poor quality control, insufficient resources allocated to safety and difficult technical problems.

The development and implementation of a credible system for assessment of safety culture is required. As well as indicating appropriate action, such a system will help generate the knowledge, understanding and expertise that is part of a good safety culture. 'Straightforward' unsafe act audits are inevitably limited in effectiveness unless there is a good safety culture which encourages a positive reaction to the results. Unsafe behaviour is an indicator of poor safety culture. In construction, which is a labour intensive industry, it is especially significant. 'Value of belief' and 'resources allocated to safety' are also important.

The outside pressures to improve safety performance in construction are relatively small when compared to those on high profile high risk industries. The development of a good safety culture therefore has to come from within the industry itself.

Positive action by the organizations and individuals in construction is another essential ingredient for the development of a good safety culture. Companies already possessing a good safety culture need to promote safety culture development in other companies and institutions outside their own organization. Professional institutions have a duty to influence, promote and encourage safety culture development throughout the construction industry.

References

Adams, J.G.U. (1988) Risk homeostasis and the purpose of safety regulations. *Ergonomics*, **31** (4), 407–428.

Bandura, A. (1977) *Social Learning Theory*. Prentice-Hall Inc., Englewood Cliffs. New Jersey.

Blockley, D.I. (1992) Engineering from reflective practice. *Research in Engineering Design*, 4, 13–22.

Booth, R.T. & Lee, T.R. (1993) The role of human factors and safety culture in safety management. In *Successful Management for Safety*. Mechanical Engineering Publications Limited, London.

Butler, B. (1989) Safety first – profits last? *Quality and Reliability Engineering International*, 5 (2), 95–100.

CBI (1990) *Developing a Safety Culture*. CBI, London.

CIRIA (1994) *Not Just an Accident*. Video on site safety. CIRIA, London.

Davies, V.J. & Tomasin, K. (1990) *Construction Safety Handbook*, Thomas Telford, London.

Dester, W.S. (1993) *The Development of a Structure for the Design of Hazard Audits*. PhD Thesis, University of Bristol.

Dester, W.S. & Blockley, D.I. (1994) Hazard Engineering. *Structural Safety*, **16** (1, 2), 3–12.

Fido, A.T. & Wood, D.O. (1989) *Safety Management Systems*. Further Education Unit, London.

Handy, C.B. (1985) *Understanding Organisations*. Penguin Books Ltd, London.

Heiermann, H. (1988). Increasing safety consciousness as an employer's task. *Glüehauf and Translation*, **124** (3), 72–76; English translation, 141–144.

Heinrich, H.W., Peterson, D. & Roos, N. (1980) *Industrial Accident Prevention: A Safety Management Approach*. McGraw-Hill Book Company, New York.

Hinze, J. & Parker, H.W. (1978) *Safety: Productivity and Job Pressures*. Proceedings of the American Society of Civil Engineers, **107**, Division CO, 27–34.

HSC (1989/90) *Annual Report 1989/90*. HMSO, London.

HSC (1992/93) *Annual Report 1992/93*. HMSO, London.

HSE (1993) *The Costs of Accidents at Work*. Health and Safety Commission, HMSO, London.

HSE (1994) *Construction Health and Safety Student Information Pack*. Health and Safety Executive, HMSO, London.

ICE (1993) *Risk Code of Practice for Engineers.* Institute of Civil Engineers, London.
Kletz, T.A. (1988) *Learning from Accidents in Industry.* Butterworths, London.
Kletz, T.A. (1990) *Critical Aspects of Safety and Loss Prevention.* Butterworths, London.
Leopold, E. & Leonard, S. (1987) Costs of construction accidents to employers. *Journal of Occupational Accidents,* 8 (4), 273–294.
McKenna, F.P. (1987) Behavioural compensation and safety. *Journal of Occupational Accidents,* 9 (2), 107–121.
Monk, D. (1988) The fine art of safety audits. *Chemical Engineering Progress,* 84 (9), 24–37.
NCE (1994) Heathrow movements 'west unnoticed'. *New Civil Engineer,* 3 November, 1–5.
Pidgeon, N.F., Turner, B., Blockley, D.I., & Toft, B. (1991) Corporate safety culture: improving the management contribution to system reliability. In *Proceedings of European Reliability Conference* (ed. R.H. Matthews), pp. 682–690. Elsevier Applied Science, London.
Reason, J. (1990) *Human Error.* Cambridge University Press, Cambridge.
SCOSS (1994) *The 10th Report of the Standing Committee on Structural Safety.* Institute of Structural Engineers, London.
Steiner, V. (1987) Assessing the Safety Climate of a Plant Yields Long Term Benefits. *Plant Engineering,* (Barrington, Illinois) 14 (8), 26–29.
Turner, B. (1978) *Man Made Disasters.* Wykeham, London.
Turner, B. (1992) The sociology of safety. In *Engineering Safety* (ed D.I. Blockley). McGraw-Hill Book Company, London.
Wilde, G.J.S. (1982) The theory of risk homeostasis: implications for safety and health. Risk Analysis, 2 (4), 209–225.