Harvey J, Bolam H, Gregory D, Erdos G. The effectiveness of training to change safety culture and attitudes within a highly regulated environment. Personnel Review 2001, 30(6), 615-636.

An attitude survey developed by Harvey et al. (1999) was used to measure responses from employees in the nuclear industry before and after a safety training intervention which all employees attended in their work teams. The first administration of the survey yielded 417 responses, and the second, administered 16 months later following the training intervention yielded 460 responses, representing response rates of over 69% in both cases. Using six factors derived earlier from the survey, significant improvements in attitudes and beliefs were found for two of the factors [and a further three factors showed rises in the same direction] for management/professional employees. For shop floor employees, only one factor showed a significant change, which was a reduction in job satisfaction over the same time period. It was concluded that the hypotheses that management would respond to the safety initiative but that shop floor would not were supported. A further hypothesis concerning grade differences in culture and attitudes was also supported. These findings are discussed in terms of culture and risk, risk taking and training, where the implications for safety training are crucial.
**Introduction**

This study investigates the effectiveness of a training programme in changing safety attitudes and culture for all employees within a highly regulated environment in the nuclear industry. Safety training programmes, such as that used in the organization investigated here, are often conducted with only minimal measures of their effectiveness, usually only at the reaction level of evaluation (Warr et al., 1971). There are many issues raised by the evaluation of safety training programmes; these include: establishing what constitute safety culture, safety attitudes, attitudes to and perception of risk, whether the training is attempting to change behaviour or attitudes or both, the links between attitudes and behaviour in a safety context, the training methods, evaluation methods and measures. In addition, the context in which the training takes place [safety policies and management style, and in this case a highly regulated organization in the nuclear industry], is likely to be a major determinant of the salience of safety and responses to it during and after a training programme.

**Safety culture**

Culture is a complex construct which has many definitions and perhaps the characteristics which have endured through most or all of these are that culture is a learned set of values which may take the form in an organization of practices interpreted through rules and norms of behaviour (Hofstede, 1991). Safety culture is believed to be a key predictor of safety performance (Cox and Cox, 1991; ACSNI, 1993), but remains a concept with no clear definition or measurement (Cox and Flin, 1998). It has often been used interchangeably with safety climate, although the two may be distinct, climate reflecting attitudes, perceptions and beliefs whilst culture is more complex, reflecting values and norms and being evident in safety management practices (Mearns and Flin, 1999). Safety culture has been described as learned behaviour, and those beliefs in the necessity, practicality and effectiveness of controls, attitudes and risk perceptions which makes people think safely and trust in safety measures, or as characteristics and attitudes in organizations which result in safety issues being a priority (IAEA, 1991; Lee, 1993; Booth and Lee, 1995). A definition accepted by many researchers is that of HSC (ACSNI, 1993: p23): "...the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. ...characterised by communications founded on mutual trust, shared perceptions of the importance of safety and by confidence in the efficacy of preventative measures".

Although there is still no consensus whether culture applies to a whole organization or to smaller groups within it (Harrison, 1972; Handy, 1985; Hofstede, 1991), recent evidence in relation to safety culture suggests that it differs conceptually for different groups of workers (employees, contractors, work gangs, etc.) in the organization, and specifically between management and shop floor workers (Chute and Weiner, 1995; Back and Woolfson, 1999; Harvey et al., 1999). Many commercial airline accidents stem from the fact that cock-pit and cabin crews represent two distinct and separate cultures and this separation serves to inhibit satisfactory teamwork which can result in lack of communication and co-ordination (Chute and Weiner, 1995). It is thus quite possible that accidents within an organization could be due to the existence of more than one safety culture which inhibits cooperation. A good example of this could be between management and shop floor workers where there is often a lack of understanding of each other which could lead to antipathy and mis-communication (Clarke, 1999).

Attitudes and behaviour have been causally linked (e.g. Fishbein and Ajzen, 1975; Ajzen, 1991; Hanisch et al., 1998) and attitudes and safety behaviour are not likely to be exceptional
to these theories. Attitudes, defined as stable predispositions, are the most comprehensive and useful indicators of a safety culture (Cox and Cox, 1991; Lee, 1994; Williamson et al., 1997). Indeed, Donald and Canter (1994) found a significant correlation between safety attitudes and accident rates. It is therefore argued that attitudes may change behaviour and thus directly and indirectly affect safety culture and accident rates, such influence being greater or less depending on the context, other psychological factors such as perception of risk, etc.

Attempting to model safety behaviour must take into account the salience of safety since this determines the importance placed upon some behaviours to the exclusion of others. Harshbarger & Rose (1991) argue that managers' roles and choices are critical in establishing a meaningful work culture and this can also be applied to the safety arena (Zohar, 1980).

There have been several attempts to define the factors which constitute a good safety culture, all of which contain the themes of commitment by both management and workforce, leadership style and communication, individual responsibility, management responsibility, risk awareness and risk taking (Cox and Cox, 1991; IAEA, 1991; Ryan, 1991; ACSNI, 1993; IOSH 1994; Diaz and Cabrera, 1997; Cheyne et al., 1998; Harvey et al., in press).

Job satisfaction is an important construct which is related to safety culture and is also affected by management style and leadership (Ryan, 1991; Lee, 1993; Williamson et al., 1997; Cheyne et al., 1998; Clarke, 1998; Hofmann and Morgeson, 1999). Using a safety survey in the nuclear industry, Lee (1993 and 1998) found that of 17 factors which discriminated between an 'accident group' [time off work for >3 days] and a 'non-accident' group, the most significant differentiator involved satisfaction and 'discontentment'. Morrow and Crum (1998) showed the importance of work-related attitudes, including satisfaction, to safety after objective indicators of safety risk had been taken into account.

It is important to note that some factors identified as relevant to safety culture, such as locus of control and sensation-seeking (Lee, 1994), may represent personality rather than attitudinal variables. This has implications for safety management insofar as attitudes may be changed whereas personality factors may not be. For example, in terms of locus of control, externals may take less preventative behaviour, as Lee suggests, and we would argue that this characteristic is relatively unchangeable and thus training to increase preventative behaviours would be less effective. However, it is implicit in attitude theory that attitudes can be changed, and thus the attitudinal and belief factors such as perceived management style, safety as a priority, communications and job satisfaction might be amenable to training or development interventions.

**Risk and culture**

Risk awareness and risk taking are highly relevant to safety culture; this is especially so when risk affects intentions indirectly through subjective norms and attitudes associated with behaviour (Strasson and Fishbein, 1990). Dake (1992) argues that most research on risk perception and risk communication has focused on possible harms, ignoring the cultural context in which hazards are framed and debated, and in which risk taking and risk perception occur. Level of knowledge is inversely related to experience of risk and whilst it is possible to view all behaviour as risk-taking, since outcomes can never be guaranteed with certainty, there are clear implications here for training and development interventions which increase risk awareness and knowledge (Sjoberg et al., 1991; Simonet and Wilde, 1997).

Risk may be seen as partly socially constructed (Dake, 1992) and this may present an explanation of and justification for the role risk perception has in maintaining a particular way
of life; therefore "top-down" management initiatives in relation to risk management might justify and maintain patterns of social relationships from which risky behaviours arise.

The theory of the social construction of risk identifies patterns of social relationships and the industry sector investigated here clearly fits into two of these - hierarchical and fatalist, where compliance to regulations and downward instruction is expected by management and where the shop floor may be characterised as being resigned to high levels of prescription and with minimum collective participation (Douglas, 1985). Fatalist shop floor workers may accept the world as capricious and desire to stay out of harm's way or not, as they so choose. Hierarchical management employees may expect shop floor workers to accept and indeed take ownership of what they have been told to do or how they have been told to behave. This social construction analysis is paralleled by attribution theory, which would imply internal attributions by the management and external attributions by the shop floor in relation to management safety initiatives (Kelley, 1973; Heider, 1976; Ross, 1977; Harvey and McGlynn, 1982; Reason, 1990; Weisz and Jones, 1993).

Dake (1992) argues that disagreements about risk are not mainly about the probability of dying but about what our world is like while we are constructing it. Thus, appeals to the shop floor on the basis of their own personal safety may be of little consequence. Even the language used may reflect this e.g. a major incident may be described as "operator error" (implicitly blaming individuals) or as caused by institutional neglect or poor policy decisions (focusing blame on larger social units). Cognitive dissonance theory would also predict more positive attitudes (ownership) by higher grades than lower grades to a safety training intervention initiated by management (Festinger, 1957).

**Individual behaviour and risk-taking**

In addition to the cultural influences, there are many variables which have major influences upon individual risk taking behaviour. In particular, the risk taking disposition of individuals may influence the effectiveness of strategies for intervention and prevention training (Cherpitel, 1999). Perceived control has been related to risk taking such that increased control of a situation is associated with a higher level of risk (Dixon et al., 1998; Horswill and McKenna, 1999). On the other hand, perception of luck is primarily determined by negative outcomes that did not happen, and is also a frequent by-product of risk taking and risk exposure (Teigen, 1998). Dear (1995) argues that people who engage in risk-taking behaviour do not necessarily try to reduce the riskiness of that behaviour but may choose to ignore the dangers associated with it. It can also be argued that many people view risk-taking as part of their everyday life at work (Niskanen, 1994).

Mood states affect the interpretation of risk taking, positive moods being associated with lower levels of risk taking than negative moods; framing (as either a threat or an opportunity) has a stronger impact on issue interpretation among people with negative than positive affect (Mittal and Ross, 1998).

Risk evaluation does not appear to be a process undertaken before decisions involving risk are taken (Kahnemann and Tversky, 1979; Wagenaar and Groeneweg 1987; Wagenaar 1992). The decision-making process involves many other factors than the risk inherent in choices, including overload from too many messages about risk, simplification of complex information resulting in systematic biases, uncertainty associated with the potential risks, attitudes, social norms and expectations (Adler et al., 1992). Thus, attitudes and values and other psychological variables, by helping to provide 'cues to action' are determinants of choice and behaviour. Some of the models of risk-taking, such as self-regulation theory (Leventhal et al.,
1983) consider that behavioural responses contain cognitive and affective components which may generate separate action plans to deal with each, which may or may not be compatible.

Much of the extensive research on risk-taking, when applied to safety behaviour, can be summarised by saying that risk evaluation is not a regular behaviour, and that the determinants of behaviour and choice include a vast array of attitudinal and motivational variables, especially those associated with past safety-related history. From this, the likelihood that risk evaluation can be encouraged by training would seem to be remote. However, it may be possible to change some of the factors which determine risk-taking behaviour, such as attitudes.

**Accident causation and safety training**

Feedback about employee performance of safe behaviours, locus of control, social maladjustment and distractibility, person-environment fit, ergonomics, housekeeping and overtime have all been associated as causes of accidents (Reber and Wallin, 1984; Hansen, 1989; Sherry, 1991; Jones and Wuebker, 1993; French et al., 1994; Lee, 1994; Ray et al., 1997). As a result of accidents being analysed so that corrective action can be taken or punishment applied, a blame-free culture is only ever partial (Lee, 1994). Indeed, Kondo (1996) argues that, after an accident, the causes are frequently attributed to human error. However, Reason (1990) suggests that [organizational] 'latent failures' will always underlie [individual] 'active errors'. This implies that latent failures are closely linked to the organization's overall culture, a view which could be derived from other investigations (e.g. Rousseau 1988, 1990).

Training is an important determinant of work performance and efficiency which is often ignored by organizations (Hyman, 1992; Graham et al., 1996). However, training may be expensive both in terms of production and wages and thus its effectiveness is important (Prais, 1995). Much investment in training is wasted because it is not underpinned by a real learning environment; many people who attend training courses do not actually know why they are there and how they will be followed up and many managers show little interest in helping or encouraging staff to implement learning/changes from their training (Lorrison and Kenjo, 1994; Cole and Brown, 1996).

If accidents can stem from misunderstanding and through the existence of two separate cultures within an organization (Chute and Weiner, 1995) then in order to improve safety, there must not only be understanding but also empathy in relation to the two cultures. Safety culture training may be aimed at changing attitudes and it may also be effective to some extent in reducing or creating insight into risk taking or facilitating the consideration of different courses of action in response to danger, but only if it is designed to take into account both the social and cultural aspects of risk and the way in which these are communicated (Dake, 1992; Vlek, 1995; Sauer, 1996). Communication of risk must be integral to a safety culture training programme, but it is a complex issue involving the definition of risk and safety in a highly regulated environment, past experience of risk, multi-attribute risk characterisation, level of risk acceptance and risk taking (Vlek, 1995; Sauer, 1996; Simonet and Wilde, 1997; Cohen, 1998).

**Training evaluation**

Several models of training evaluation exist, all of which include the notion of different levels and criteria of evaluation, although these may be seen as relatively primitive in approach (Kirkpatrick, 1959, 1996; Ban and Faerman, 1990; Harrison, 1992; Kraiger et al., 1993; Mitchell, 1994; Lupton et al., 1999).
The most relied upon indicator of training effectiveness is changes in job performance (Clegg, 1987). However, this would imply the measurement of accidents as a criterion for the evaluation of safety training, presenting several problems such as accidents being relatively low-frequency events and the non-recording of incidents in most workplaces (Perkins, 1995; Lewis et al., 1998). A further issue is the large number of confounding variables which cannot be controlled or accounted for. The isolation of results is problematic because it is hard to agree the goals which are to be achieved by safety training (Mitchell, 1994).

There are several different tools for evaluating training, all with their own strengths and weaknesses (Cantor, 1991; Goldstein, 1991; Kraiger et al., 1993; Sackett and Mullen, 1993; Haccoun and Hamiaux, 1994; Simon et al., 1996). One such method with at least some proven validity in relation to safety is the measurement of attitudes where they are specifically rather than generally measured (Fishbein and Ajzen, 1975; Ajzen, 1991; HSE, 1991; Donald and Canter, 1994; Lee 1994).

Evaluation must inherently be set against objectives, which in turn determine the design of the programme. For example, training/intervention programmes designed primarily to reduce recidivism are more effective in reducing both violations and accidents of repeat offenders than instruction that is solely directed toward accident prevention (McKnight & Tippetts, 1997). Weidner et al (1998) suggest that training should emphasise the technical aspects of health and safety, should include demonstration and hands-on techniques, and that integrated organizational support for implementation of health and safety practices is critical.

**Training effectiveness**

The concept of safety culture can apply at group level, and thus training employees in teams can have a number of advantages, especially greater inter-positional knowledge under high-workload performance conditions and implicit coordination without overt communication (CannonBowers et al., 1998). Feedback with goal setting may maximise the effectiveness of a behavioural safety training programme in the workplace (Kraiger et al., 1993; Nyandindi et al., 1995; Ray et al., 1997). Multi-method and participative small group training would seem to have advantages for training in safety (Harrison, 1992; Lamontagne et al., 1992; Chapman et al., 1996). Hands-on training methods, especially behaviour modelling, result in superior retention of knowledge, transfer of learning and end-user satisfaction (Simon et al., 1996; Weidner et al., 1998).

If workers identify with the person giving the training then their behaviour changes as a result of the training more than those who do not identify with the trainer (Kurtz et al., 1997). Thus, if safety training is administered by a professional staff trainer or manager then it is less likely to be effective for workers than training provided by say, an acknowledged peer. However, more autocratic management styles will render even results-focused training ineffective, since the manager's will may prevail over a team's efforts to improve it's safety performance (Meyer, 1994); in contrast, caring, supportive and empowering management can significantly improve the impact and effectiveness of safety training (Niskanen, 1994; Cole and Brown, 1996; Thompson, 1996).

**Summary and rationale for this study**

The conclusions that can be drawn from the existing literature are as follows. Whilst safety culture may well be a strong determinant and potential predictor of safety performance, it is nevertheless a complex construct. It is likely that safety culture is conceptually different for
different groups of workers, particularly managers and shop floor employees. Theories of risk behaviour, cognitive dissonance and attribution suggest that attempts to train employees to change their safety-related attitudes and behaviour may be met with limited success, depending on many cultural and context variables.

Training to change attitudes and safety culture must be carefully designed to take into account the complex nature of risk and perception of risk, the need to involve the employees and reduce the possibility of 'latent' failures. Attitudes have been shown to be determinants and correlates of accidents and safety behaviour, and measurement of attitudes can thus be used to evaluate the effectiveness of training to change safety culture.

This study concerns the investigation of safety culture change following a training intervention for all employee levels in a highly regulated work environment. After the first stage, time 1 (T1) of measuring safety culture and attitudes, a safety culture training initiative was taken. The safety culture and attitude measurement was repeated 16 months later at time 2 (T2). This study was exploratory in nature, investigating whether or not any changes in safety culture took place during that time. On the basis of current literature, the following hypotheses are advanced:

**H1:** From literature pertaining to cognitive dissonance and attribution theories (Festinger, 1957; Kelley, 1973; Harvey and McGlynn, 1982; Reason, 1990; Weisz and Jones, 1993) predicting 'ownership' of the safety culture change programme:
That management will show significant positive changes in safety-related work attitudes and attitudes to risk-taking and perceptions of risk between T1 and T2.

**H2:** From the literature on social construction theory and lack of involvement in the training process: (Dake, 1992; Vlek, 1995; Sauer, 1996; Simonet and Wilde, 1997; Cohen, 1998).
That shop floor employees will show modest or no changes in safety-related attitudes, risk taking or awareness of risk between T1 and T2.

**H3:** From the evidence that safety culture has several factors within it and that an organization may contain more than one safety culture (Harrison, 1972; Zohar, 1980; Handy, 1985; Cox and Cox, 1991; Harshbarger and Rose, 1991; Hofstede, 1991; IAEA, 1991; Ryan, 1991; ACSNI 1993; Lee, 1993; IOSH 1994; Lee, 1994; Booth and Lee, 1995; Williamson et al., 1997; Cox and Flin, 1998; Back and Woolfson, 1999; Harvey et al., in press)
That there will be significant grade differences at both T1 and T2.
Analysis of safety culture training effectiveness

Harvey, Bolam, Gregory & Erdos

Methodology

Method

A survey of 60 Likert-style items previously constructed in order to measure attitudes and perceptions related to safety (Harvey et al., in press) was conducted at two times 16 months apart. In addition, whether the employee was shop floor or supervisor/management/professional [SMP] was identified. Information about age, sex and length of service was only available for the T2 survey. Space was left for any comments respondents might wish to make. Between T1 and T2 all employees in the plant were given safety training. The training is described below:

The context is one large department within a nuclear processing plant in the United Kingdom, described in further detail as the sample. Employees at all levels in the plant attended a one day training workshop in teams of people with whom they would normally be working; these included managers, supervisors and shop floor workers. Initially, the workshop trainers were management consultants, who later trained trainers from the organization to run the large volume of workshops. The purpose of the workshops, devised by an outside agency, was to raise awareness of safety issues and safety behaviour in a general way and to give all employees the opportunity to give feedback about what they felt was right or wrong with their own work area. The workshops were followed up with the teams being provided with feedback sheets about the issues they had raised and development programmes which addressed the most important of these issues, actions that might be undertaken and any other possible responses raised from this exercise. All the team feedback was given to a central body in the organization who generated the development programmes from them and monitored the team's subsequent responses.

Depending on the nature of the issues involved, the feedback and subsequent development programmes were worked on by the teams after T1, some quickly whereas others were still ongoing 18 months after the safety training initiative. As part of a longer term development, these workshops will have been run again following the T2 survey. On average, each employee will: have undergone one 1-day workshop each year, have worked in their team to respond to the feedback/development programmes generated and have had the opportunity to attend a company safety conference (so far, approx. one in six chose to do this). In addition, in support of this activity, safety posters have been used along with general summary feedback from the attitude survey at T1 to reinforce awareness of safety culture change.

This safety initiative must be set in the context that in a highly regulated environment such as this, there are many management initiatives to which employees are exposed, in areas such as quality and maintenance in addition to many in relation to safety.

The attitude scale (Harvey et al., in press) was derived before the training intervention in order to provide both a 'snapshot' of attitudes and perceptions within the department and also to provide a device which would allow these to be tracked over time; the measure was specifically designed in consultation with the department to cover issues that were considered specially relevant to this industry. The scale used was of Likert-type with six answer points, ranging from strongly agree, agree, mildly agree to strongly disagree. There is no consensus in the literature regarding the number of answer points, although reputable published scales would seem to contain five, six or seven answer points (e.g. HSE, 1998); in this study, there was no mid-point because it was felt that asking respondents to actually agree or disagree with statements was preferable to a scale with a neutral mid-point.
Harvey et al. (in press) identified, through a varimax rotation of the scale, six orthogonal factors in safety culture that were common to both shop floor and management employees. The factors are (with number of items common to both groups and Cronbach's $\alpha$): perceived management style and communications (including how much and how often the manager communicates, respect for the manager's attitude and commitment to safety, the manager listening to safety ideas, 13 items, $\alpha=.882$); organizational involvement and responsibility (including seeing safety as within one's role and as a priority, 6 items, $\alpha=.605$); risk-taking of self and responses to risk-taking of self and others (including showing off, taking small risks, cutting corners, seeing slow workers as a nuisance, 5 items, $\alpha=.704$); job satisfaction (including recommending job to others, being interested in the job, 6 items, $\alpha=.742$); complacency (including pride in safety attitudes, feeling that everything is already as safe as it can be, 6 items, $\alpha=.654$); risk awareness (including being a good judge of risk, would say if someone's behaviour was unsafe, 5 items, $\alpha=.621$). Factor scores were calculated by simple aggregate of the scores of items within each factor, and in this paper, these factor totals are used rather than 60 individual items in order to simplify data handling and aid comprehension.

Sample
The sample consisted of all employees in one plant of a large nuclear power operations site. In recent years, there has been restructuring in terms of downsizing in the organization; the emphasis in the business has increasingly been towards the work of this plant, such that it currently generates between 10 and 15% of all earnings, a figure targeted to rise in the future.

The plant is seen in the organization as an emerging core area of the business group, being a major 'money earner'. Management here might see themselves as 'head of the pack' in many ways, typified by being particularly good at refresher training, consultation and higher levels of displayed commitment by management to various (safety) initiatives. Management are largely drawn from production or operations backgrounds. The workforce might be described as skilled manual, mostly with relatively long service with the company. There were 600, predominantly male, employees in the plant at time T1 and 644 at time T2. The distribution of responses is shown in table 1; it is proposed that the high response rate is indicative of safety being considered important by all employees in this study, as one might predict with a work force in a highly regulated environment.

Table 1: Responses for the plant at T1 and T2 by employee type

<table>
<thead>
<tr>
<th>Shop floor</th>
<th>SMP</th>
<th>not known</th>
<th>total</th>
<th>total N</th>
<th>% resp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>166</td>
<td>227</td>
<td>24</td>
<td>417</td>
<td>69.5</td>
</tr>
<tr>
<td>Time 2</td>
<td>171</td>
<td>288</td>
<td>11</td>
<td>480</td>
<td>74.0</td>
</tr>
</tbody>
</table>

Procedure
The two periods of data collection were 16 months apart: at both times, a covering letter accompanied the survey so that respondents were aware that the survey was being conducted in complete confidence by a person from outside the organization. Respondents were assured that nothing reported could in any way be traced back to them individually, and were given a
pre-addressed envelope to facilitate an anonymous response. For T1, the letter was introductory in nature; for T2 the letter referred to the feedback presentations, written by the researcher, that had been made by management to all employees through the workshops and team briefings and asked all employees to take the time to fill in the questionnaire again so that responses could be tracked over time. A reminder was sent to all respondents one month after the questionnaires had been distributed.

Results
The data, being ordinal in nature and not normally distributed, do not meet all the assumptions for parametric tests, and thus the main analyses are all conducted using non-parametric tests. Although many respondents will have appeared as data at both T1 and T2, they are completely anonymous and cannot be treated as related samples, and thus to compare two groups, Mann-Whitney tests were conducted for rigour. Parametric measures are used throughout only as descriptors and indicators. Thus, to obtain an overall general idea about the data and to ascertain whether there were any interactions, 2-way ANOVAs by grade and time period were conducted in all six factors. The findings are summarised in table 2.

Table 2: Summary statistics for two-way analysis of variance of time period and grade for six factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Grade F</th>
<th>prob</th>
<th>time period F</th>
<th>prob</th>
<th>interaction F</th>
<th>prob</th>
<th>N items in scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Perceived man style</td>
<td>98.47</td>
<td>&lt;.0001</td>
<td>15.44</td>
<td>&lt;.0001</td>
<td>4.82</td>
<td>.0284</td>
<td>17</td>
</tr>
<tr>
<td>2 Responsibility</td>
<td>18.19</td>
<td>&lt;.0001</td>
<td>n.s.</td>
<td>2.95</td>
<td>n.s.</td>
<td>&lt;.0001</td>
<td>11</td>
</tr>
<tr>
<td>3 Risk taking</td>
<td>1.69</td>
<td>n.s.</td>
<td>2.79</td>
<td>n.s.</td>
<td>n.s.</td>
<td>&lt;.0001</td>
<td>8</td>
</tr>
<tr>
<td>4 Complacency</td>
<td>16.22</td>
<td>&lt;.0001</td>
<td>22.75</td>
<td>&lt;.0001</td>
<td>.0002</td>
<td>2.52</td>
<td>5</td>
</tr>
<tr>
<td>5 Job satisfaction</td>
<td>69.11</td>
<td>&lt;.0001</td>
<td>5.12</td>
<td>.0240</td>
<td>.0002</td>
<td>8.53</td>
<td>8</td>
</tr>
<tr>
<td>6 Risk awareness</td>
<td>23.28</td>
<td>&lt;.0001</td>
<td>.60</td>
<td>n.s.</td>
<td>.0036</td>
<td>4.53</td>
<td>4</td>
</tr>
</tbody>
</table>

It can be seen in table 2 that four of the factors (1, 4, 5 and 6) show both time period and grade differences. Factor 2 shows significant grade differences but no time period differences; the ANOVA on factor 3 yielded no significant differences by time period or grade.

In order to examine these findings further, and to examine the nature of the interactions, the data were further analysed separately for grade and time period. These are considered below in order of presentation of the factors in table 2. Means and standard deviations are given in subsequent tables as descriptors, but the analyses were performed using the appropriate non-parametric Mann-Whitney U test.

Table 3 shows that for factor 1, the increase is largely amongst the SMP group, and that there are grade differences for both time periods. Mann-Whitney tests were therefore conducted separately for each grade group to compare T1 and T2 responses, yielding \( z = 5.16, p<.0001 \) for SMP and \( z = 1.24, \) n.s. for the shop floor. The highly significant grade differences were
also confirmed by Mann-Whitney tests for each time period, yielding \( z = 5.41 \) for T1 and \( z = 8.05 \) for T2, both \( p < .0001 \).

Table 3: Means and standard deviations for factor 1: perceived management style and communication

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \bar{x} )</td>
<td>s.d.</td>
</tr>
<tr>
<td>Shop floor</td>
<td>63.08</td>
<td>12.32</td>
</tr>
<tr>
<td>SMP</td>
<td>69.81</td>
<td>11.36</td>
</tr>
</tbody>
</table>

In the summary ANOVAs in table 2, factor 2 (responsibility) showed a significant grade effect, no time period effect but an interaction effect approaching significance. The means given in table 4 show a picture of different directions of change for the two grade groups. The mean score rose for the SMP group but fell for the shop floor group between T1 and T2, although neither effect was significant on its own. Mann-Whitney tests on factor 2 showed significant grade differences at both T1 and T2, with \( z = 1.99 \), \( p = .0466 \) and \( z = 3.67 \), \( p = .0002 \) respectively.

Table 4: Means and standard deviations for factor 2: responsibility, commitment and involvement

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \bar{x} )</td>
<td>s.d.</td>
</tr>
<tr>
<td>Shop floor</td>
<td>57.21</td>
<td>4.92</td>
</tr>
<tr>
<td>SMP</td>
<td>58.16</td>
<td>4.86</td>
</tr>
</tbody>
</table>

Factor 3, risk-taking of self and responses to risk-taking of others, showed no significant grade or time period differences, either with the ANOVA or with Mann-Whitney tests conducted separately as above.

Table 5: Means and standard deviations for factor 4: complacency

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \bar{x} )</td>
<td>s.d.</td>
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</table>
Factor 4, complacency, showed very significant effects in the ANOVA, including an interaction effect; the means table for the factor is shown in table 5. Mann-Whitney tests were conducted to ascertain which differences were significant, and these clearly point to an increase in the scores of SMP from T1 to T2 but no change for shop floor over the same period (z= 6.56, p< .0001 and z= .75 n.s. respectively). At T1, the two grade groups had nearly identical scores (z= .20, n.s.) whereas at T2, the grade groups were significantly different (z= 5.28, p< .0001). The means table clearly show that the only real change is the large rise in the mean score of the SMP group from T1 to T2; this would account for all three significant effects shown in the ANOVA in table 2.

Factor 5, job satisfaction, also showed all effects significant in the ANOVA in table 2. These are examined further in table 6. Mann Whitney tests confirmed that the difference between T1 and T2 for SMP was not significant (z= 1.43, n.s.) but the difference for the shop floor was highly significant in a downward direction (z= -3.70, p=.0002). The grade differences were both significant: at T1 z=2.99 p=.0028 and at T2 z= 8.11, p< .0001.

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
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<tbody>
<tr>
<td>Shop floor</td>
<td>28.28</td>
<td>25.58</td>
</tr>
<tr>
<td>SMP</td>
<td>30.37</td>
<td>31.02</td>
</tr>
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</table>

Table 6: Means and standard deviations for factor 5: job satisfaction

Factor 6, risk awareness, showed significant grade differences and an interaction effect but no change between T1 and T2. The means table for factor 6 is given in table 7. Mann-Whitney tests showed a very significant difference between the grades at T1, but none at T2 (z= -4.89, p< .0001 and z= -1.77, p= .0768 n.s. respectively). When comparing the change between T1 and T2 for each grade, both results were nearly significant (Shop floor z= -1.91, p=.0561 and SMP z= 1.77, p=.0768) but in opposite directions. These findings would account for the interaction effect and also the low F- value for time period for this factor.

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<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
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<tbody>
<tr>
<td>Shop floor</td>
<td>16.48</td>
<td>16.77</td>
</tr>
<tr>
<td>SMP</td>
<td>16.59</td>
<td>19.05</td>
</tr>
</tbody>
</table>

Table 7: Means and standard deviations for factor 6: risk awareness
Summary of findings and testing of hypotheses:

These analyses indicate that five factors (1 perceived management style, 2 responsibility, 4 complacency, 5 job satisfaction and 6 risk awareness) show rises in the scores for the SMP group, although only for factors 1 and 4 were these rises significant. These findings support hypothesis one - that management grades respond positively to safety initiatives.

Factor 5 (job satisfaction) showed a highly significant drop in the mean score for the shop floor group. No other factor showed any significant change between T1 and T2 for this group. Both of these findings support hypothesis 2 - that shop floor grades show limited response to safety initiatives.

Factors 1 (perceived management style), 2 (responsibility), and 5 (job satisfaction) showed that there are significant differences in responses between grades at both times of measurement. These clearly support hypothesis three. Additionally, factor 4 (complacency) yielded a significant grade difference at the time T2 only as a result of a change in the SMP mean score from T1 to T2, whilst factor 6 (risk awareness) yielded a significant grade difference at T1 only, as both groups' means had moved closer together at T2.

Factor 3 (risk-taking and responses to risk) showed no significant differences in scores at the two times of measurement and no grade differences. Thus, attitudes to risk taking did not change in the predicted direction for the SMP group.

Thus, it can be concluded that these findings generally support the hypotheses, with the exception of risk-taking and responses to risk-taking of others. It is also evident from the scoring and response rates that employees generally here consider safety to be important.

Discussion

A main purpose of the training intervention examined in this study had been to change the safety culture. In this organization, safety is highly salient and occupies the time and energy of many employees; the findings must be considered in that context. The organization was operating on the basis that if safety attitudes changed, then safety behaviour would also change, a belief well founded in the literature (Fishbein and Ajzen, 1975; Ajzen, 1991; Cox and Cox, 1991; Lee 1994). However, these findings imply, at first glance, that the training has had an effect only for the higher grades of employee. The results strongly support the notion of two safety cultures operating, whose effect is to render the safety culture training programme differentially effective.

Culture and risk

The trainees took part in teams - the same teams which would act upon what they had learned during the next 12 or more months. This was intended to enable employees to identify with what was happening and work together rather than seeing it as a solely management initiative. An important function of training in teams may be to increase not only the employees' feelings of involvement, but also to enhance managers' interest in employees' behaviour (Zohar, 1980; Lorriman and Kenjo, 1994; Cole and Brown, 1996). However, the existence of two different

<table>
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<th>T1</th>
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</thead>
<tbody>
<tr>
<td>Shop floor</td>
<td>18.00</td>
<td>2.37</td>
<td>17.37</td>
<td>2.48</td>
</tr>
<tr>
<td>SMP</td>
<td>16.68</td>
<td>2.47</td>
<td>17.04</td>
<td>2.34</td>
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cultures here could act to inhibit teamwork and cooperation and be a direct cause of accidents (Chute and Weiner, 1995). An implication of this finding is that the team approach to safety training has not been able to bridge the cultural divide and may even have reinforced it.

The role and commitment made by managers can be critical in establishing a meaningful safety culture (IAEA, 1991; Ryan, 1991; ACSNI, 1993; IOSH 1994) but if the employees share a different safety culture, the management role may be seen differently even in a joint team working safety training initiative such as this (CannonBowers et al., 1998). It is unlikely that a totally blame-free safety culture exists (Lee, 1994) and 'latent failures' of the organizational culture, such as different cultural values suggested by these findings, imply different psychological contracts in relation to safety attitudes and behaviour which may render combined training difficult to achieve (Rousseau 1988, 1990). Thus, any increase in positive attitudes and safety behaviour derived from being trained in teams may have been attenuated by the existence of two safety cultures.

The notion of risk as socially constructed has important and powerful implications for the findings in this study (Dake, 1992). The theory seeks to place risk and safety into the cultural context, and thus the safety training programme may have been seen as a 'top-down' initiative, serving to justify and maintain the pattern of social relationships from which the safety issues and risky behaviour emanated in the first place (Douglas, 1985; Dake, 1992). There is an inherent conflict here: 'hierarchical' management may at once expect automatic compliance to regulations and prescribed behaviour yet in the safety training context expect involvement and ownership of safety initiatives by the 'fatalist' workforce. Such a conflict may also be embedded in everyday language where at some levels blame is individually attributed to others [e.g. operator error] but at other levels it is policy which shoulders the blame in a less well defined way. Thus at the shop floor level, where social relationships are primarily fatalist, i.e. having to accept strict regulations and holding 'why bother' attitudes, the impact of safety culture training might well be attenuated. The imposition of hierarchical social relationships may result in loss of respect for authority (Douglas, 1985; Dake 1992) and thus safety programmes initiated by management are less likely to result in improved attitudes, particularly in relation to communications and personal responsibility, both of which are really not part of fatalistic social relationships. This might explain a lot of the attitudes amongst the shop floor workers, particularly the drop in job satisfaction, and also the self-serving increase in positive responses that were found for the SMP group (Reason, 1990; Dake, 1992).

**Risk-taking**

The part of the scale which showed no change between T1 and T2 for either grade group was risk-taking. This is surely one area where the management might have hoped for changes. However, responses to risk may be complex, depending on mood state, beliefs concerning and level of perceived control and luck, and not always rationally aimed at risk reduction (Dear, 1995; Dixon et al., 1998; Mittal and Ross, 1998; Teigen, 1998; Horswill and McKenna, 1999). Further, there may be deliberate choices to engage in risky behaviour and to ignore dangers associated with it (Dear, 1995), possibly justifying this with the belief that all behaviour is inherently risky (Simonet and Wilde, 1997). The risk-taking disposition of individuals holding such beliefs may well have influenced the effectiveness of this safety programme, as attribution theory would predict (Kelley, 1973; Weisz and Jones, 1993; Cherpitel, 1999).

Risks are not necessarily self-evident, and perception of risk can be manipulated (Horswill and McKenna, 1999). Dake (1992) argues that disagreements about risk are not mainly about
the probability of dying but about what our perceptual and attitudinal world is like while we are constructing it. Risk seems to affect intentions indirectly through subjective norms and attitudes associated with behaviour (Strasson and Fishbein, 1990). Employees may accept the world as capricious and desire or choose to place themselves into more or less risky situations (Dake 1992). Thus, appeals to the shop floor on the basis of their own personal safety may be of little consequence, despite the evident attractiveness of conducting training with this emphasis, as in this case.

Many people view risk taking as part of everyday life, a view which is probably stable and enduring, and do not undertake risk evaluation, even in contexts where safety is highly salient (Kahnemann and Tversky, 1979; Niskanen, 1994). This may account for the finding that risk-taking remained at the same level, even after training. The fact that there may be a high level of emotional engagement with the organization, in the sense that dislike of nuclear processing would (in terms of cognitive dissonance [Festinger, 1957]) be incompatible with working in that industry, may reinforce existing attitudes to risk (Leventhal et al., 1983).

Training
The safety training programme here can be considered to have internal validity insofar as it has achieved attitude change for the higher grades (Goldstein, 1991). It was conducted participatively in small groups, which would seem to be an effective approach (Nyandindi et al., 1995; Chapman et al., 1996; Simon et al., 1996). However, the safety programme was initiated by management: this was inevitable since there was considerable cost involved. Further, the trainers were themselves 'appointed' by management before being trained by the consultants. Thus, there may be issues of perceived 'ownership' by management who would, after the training programme had taken place, be likely to demonstrate more positive attitudes and behaviour in relation to safety to avoid cognitive dissonance (Festinger, 1957). The shop floor who may identify less with the programme experience little or no dissonance and were therefore less likely to change their attitudes. Dissonance theory is clearly one possible way of accounting for the findings in this study. The results focus of the training in terms of action outcomes, not generated directly by the teams themselves, may also have contributed to these differences in responses and may contribute to teams' lack of empowerment and even to a loss of agreement about the goals of the training (Meyer, 1994; Kraiger, 1995).

Attribution theory also offers an explanation of the different results found for the SMP and shop floor employees: if management have taken greater ownership of the safety training programme, then they are more likely to make positive attributions to themselves about any changes that result from it- an example of a self-serving attribution (Hewstone, 1989; Johns, 1994). On the other hand, if the shop floor have little identification with the initiative, then they are unlikely to attribute any success to management and this will be reflected in their attitudes to management style, which would remain un moved or reduce; this would be a fundamental attribution error (Kelley, 1973; Sherry, 1991; Kurtz et al., 1997). This problem would be exacerbated in the context of the shop floor perceiving the training programme to be just one more management 'scheme' and being unable to differentiate it's importance from other initiatives or if they perceive that managers are not interested in encouraging the implementation of learning (Lorriman and Kenjo, 1994; Cole and Brown, 1996).

The safety training programme investigated here may be seen as directed generally towards accident prevention, whereas had it been more closely directed towards the reduction of recidivism or the more technical aspects of safety, it might have been more effective (Jones and Wuebker, 1993; French et al., 1994; Kondo, 1996; Simon et al., 1996; McKnight and Tippetts, 1997; Weidner et al., 1998). In fact, a mixture of approaches and focuses with
clearly specified objectives are the most effective means of conducting this type of programme (Harrison, 1992; Lamontagne et al., 1992; Kraiger et al., 1993; Kraiger, 1995).

**Conclusion**
These findings reinforce the notion of two different cultures, since the training was clearly differentially effective in changing attitudes. Further, the findings imply that training in mixed teams may well have been rendered ineffective for shop floor employees by this cultural divide. However, the cultural divide within this organization is not worse than that in any other organization; the only real difference between this organization and thousands of others is the pervasive importance of safety.

An important question is therefore: is it possible to design training to change an important area of culture by using work teams? The answer to this is yes- but only so long as the teams are already developed to work together to eliminate as far as possible the cultural divide, by giving ownership of the team to all rather than having initiatives and developments which are top-down driven. This issue concerns all areas of teamwork, not just safety. There is also the issue that many attitudes and perceptions related to risk have been developed over years and a few single days of even the best teamwork may not be sufficient to produce significant changes in risk taking behaviours and safety attitudes.

The context of this investigation is a very special sort of organization- one where necessarily safety must assume paramount importance. This may not only have produced much higher 'scores' on the measures but may also have generated factors which differ from those in other organizations where safety is barely an issue at all. It may be that in terms of safety, there is no cultural divide in these latter organizations, such that all employees feel similarly about the issues- but barely 'feel' anything at all unless pressed to by a questionnaire. In this organization, it was clear from the scoring and response rates that safety was considered important by all employees.

More research is needed in the area of developing safety culture change through training, about what can and cannot be achieved and with which sectors on employees in an organization, and indeed in terms of how to increase the salience of safety in many workplaces.

**References**


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