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A critical review of safety initiatives using goal setting and feedback

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A review and synthesis of behavioural safety literature identified three behaviour change perspectives: cognitive (goal setting); behaviourist (behaviour modification); and eclectic (social learning). Bandura's social learning theory usefully integrates the divergent philosophies of Locke's goal setting and Luthan's behaviour modification. Social learning theory assumes that behaviour is controlled by internal processes and environmental stimuli, and so human action can be explained by the combined effect of goals and feedback. The effectiveness of behavioural safety has been demonstrated consistently, but, despite some success, token reward programmes are controversial because they are close to 'paying for safety'. Researchers have overwhelmingly favoured initiatives based on goals and performance feedback without material reward. Goals and feedback produced good results in the varying cultures of North American, European and Middle-East manufacturing environments, including mines, chemical plants, laboratories, paper mills and shipyards. Goals and feedback, aimed principally at operatives, have been used to improve safety in Finnish, British and Hong Kong construction industries. It is also clear that their effectiveness is strongly related to management commitment; and that they must be supported by a developed safety infrastructure. This suggests that goals should also embrace management safety behaviours, in order to improve management commitment.

Keywords: Safety, organizational psychology, organizational behaviour

Introduction

The construction industry's safety performance continues to be a source of concern. Though the number of fatal injuries has fallen to around 90 deaths per annum in recent years, this still means that almost two people are killed each week in the construction sector. These fatalities are only the tip of the iceberg; there are many thousands more injuries which result in more than three consecutive working days' absence from work.

Traditionally measures aimed at improving construction safety performance have focused on engineering control, or legislation such as the Safety at Work Regulations 1992 and the Construction (Design and Management) Regulations 1994. However, the limitations of a legislative approach have been recognized in other industries. Several manufacturing industries have shifted emphasis from enforcement to persuasion. A human factors era has emerged in recent years, an era that offers considerable utility for safety practitioners (McAfee and Winn, 1989). A Director-General of the Health and Safety Executive (HSE) has stated that: 'we seem to have passed the era where the need was for further engineering safeguards … what we need to do now is capture the human factor' (Rimmington, 1993) and this has been exemplified, in recent years, by increased HSE activity in human factors research.

Whittington *et al.* (1992), adopting a top-down approach, identified management or latent factors in organizations that influence the accident causation sequence. However, these researchers stopped short of applying a strategy to improve the situation. Robertson *et al.* (1999), adopting a bottom-up approach, identified operative or proximal factors that influence the accident causation sequence. These researchers went on to implement a strategy on a number of project sites to improve safety behaviour. This strategy involved sampling the incidence of unsafe acts and conditions observed at a site and displaying

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this performance graphically. Edwin Locke's management theory of goal setting (Locke and Latham, 1990) was then used to motivate employees to improve their safety performance.

There has been a considerable amount of international research into the impact and control of human factors in safety performance, much of it in the areas of goal setting and feedback. This paper reviews such attempts to improve safety behaviour in international manufacturing and construction industries, and analyses their significance for UK construction safety management.

Behavioural safety

Three related perspectives have emerged as theoretical frameworks or paradigms of worker behaviour change: behaviour modification (Luthan and Kreitner, 1974); goal setting (Locke, 1968); and social learning (Bandura, 1977).

Behaviour modification

Behaviour modification assumes that behaviour is a function of its consequences. This premise stems from Thorndike's 'law of effect' and Skinner's 'principle of reinforcement'. Luthan and Kreitner (1974) developed these concepts, describing standards or goals as stimuli or antecedents, and feedback or incentives as rewards or consequences. Thus, behaviour is controlled by past reinforcements and not internal processes.

Behaviour modification has been described as 'the best technique for diagnostic evaluation of behaviour' (Luthan, 1982) and associated with many effective industrial (Feddor and Ferris, 1981; O'Hara *et al.*, 1985; Luthan and Martinko, 1987) and safety interventions (Sulzer-Azaroff, 1987). The Luthan and Kreitner (1974) model is shown in Figure 1.

Functional analysis identifies antecedents and consequences for use in an intervention to improve target behaviours. In the field of safety, experimental protocols have introduced: (1) goals; (2) feedback; (3) praise; (4) training; (5) tokens; and (6) a combination of these. Behaviour modification experiments using techniques to improve safety have been reviewed by Sulzer-Azaroff (1982, 1987), McAfee and Winn (1989) and Sulzer-Azaroff *et al.* (1994).

Goal setting

Goal setting assumes that the desire to achieve a goal is one of the immediate causes of behaviour. Locke (1968) developed one of Taylor's scientific principles, applying the role played by intentions in determining individual choice of effort. Goal setting is a focused development of behaviour modification where conscious decisions to pursue goals determine the level of effort and the direction of this effort (Locke *et al.*, 1981).

Goal setting has been described as 'a milestone in organizational psychology' (Latham and Lee, 1986). Research has suggested that 99 out of 110 laboratory and field studies have supported the effectiveness of goal setting. A continuous programme of research (Locke *et al.*, 1981; Mento *et al.*, 1987; Locke and Latham, 1990) showed that:

(1) *Difficult* goals lead to higher performance than easy goals, so long as they have been accepted.
(2) *Specific* goals lead to higher performance than vague goals of the do-best type.
(3) *Feedback* is essential for effective goal setting.
(4) Assigned goals and participative goals can be equally effective, as long as *acceptance* of the goal leads to *commitment* to achieving it.
(5) Goal *commitment* may be improved financial incentives or by making the goal acceptance public.
(6) Complex goals may demand task *strategies*, containing problem-solving initiatives, as well as commitment.
(7) The only individual differences found to affect goal success are self-perceived ability, *self-efficacy* and *ability*.

Locke and Latham's model of goal setting is shown in Figure 2.

In worker safety, goals and feedback have produced many effective interventions in manufacturing (e.g. Reber and Wallin, 1984) and construction (e.g. Duff *et al.*, 1993).

Social learning

Social learning represents a framework which can integrate the divergent philosophies of behaviour modification and goal setting, explaining the parts that both antecedents (such as goals) and consequences (such as feedback) play in determining behaviour. It is clear that a purely behaviourist interpretation of human action is incomplete and antecedents cannot be ignored. Social learning theory (Bandura, 1977, 1986) presents a more complete model. Social learning theory offers a framework for integrating behaviour modification and goal setting (Latham and Saari, 1979; Davis and Luthan, 1980; Locke *et al.*, 1981).

Social learning theory acknowledges that individual functioning is seen as an interaction between cognitive,

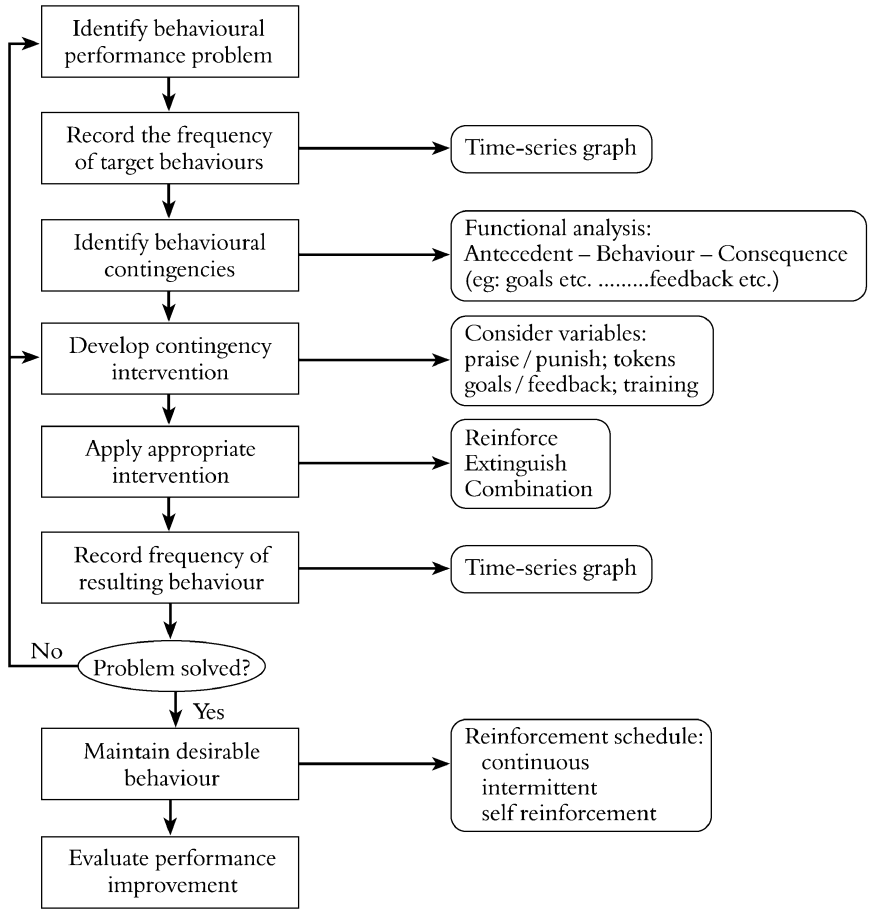

Figure 1 Luthan and Kreitner's (1974) model of organizational behaviour modification

behavioural and environmental factors. This dynamic interaction between the person, the job, and the situation is known as reciprocal determinism. It recognizes that behaviour does not occur in isolation, being caused by conscious intentions to achieve goals, and by reinforcing consequences leading to intrinsic or extrinsic satisfaction. Feddor and Ferris (1981) called social learning theory an integrated model for use by those interested in applying management theory to organizational problems and Mento *et al.* (1987) suggested that:

> If ever there was a viable candidate for elevation to the lofty status of scientific law … then the relationship between goals coupled with feedback are worthy of serious consideration.

This suggests that goals and feedback together represent a valid safety improvement strategy in which unsafe acts are measured as a baseline of current behaviour, barriers to improvement are identified and removed, goals are set, performance is evaluated and feedback made (Figure 3).

Behavioural safety management

Bird and Schlesinger (1970) are generally acknowledged to be the first researchers to advocate the use of behavioural techniques in safety management, advocating the use of management strategies such as feedback and supervisory praise. Fitch *et al.* (1976) and Brown (1977) also advocated the control of the workers' environment by rewarding safe behaviour. Much applied research, adopting posted feedback coupled with goal setting, followed; studies were summarized by McAfee and Winn (1989).

McAfee and Winn (1989) observed that studies have used many different types of safety measure (e.g. causal (ear protection), end-result (number of accidents) and short-term (percentage of safe behaviours)) and have employed many different independent variables to enhance safety (e.g. goals, feedback, praise, training and token rewards). Studies have tended to use these variables in combination, making it difficult to establish individual cause–effect relationships. However, the 24 studies McAfee and Winn reviewed offered over-

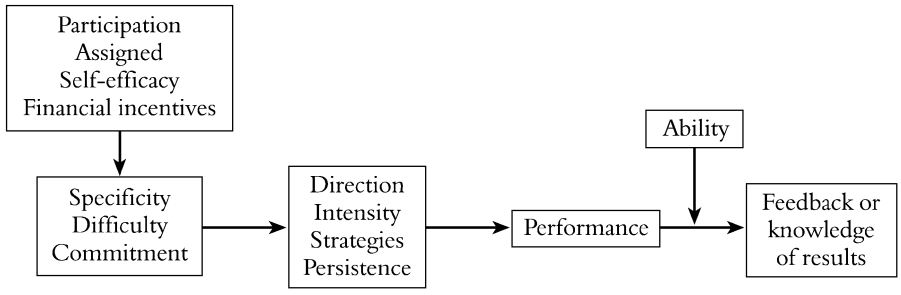

Figure 2 The fundamentals of Goal Setting Theory (Lock and Latham, 1990)

whelming evidence to support the overall utility of behavioural safety.

Tokens/prizes coupled with goals and/or feedback

Some studies have used contrived incentives (e.g. redeemable tokens or luxury cars) in conjunction with natural incentives (e.g. goals and feedback). Behavioural initiatives that use contrived incentives can be divided into two groups: the first, methodologically weaker, uses an expensive prize, therefore offering extrinsic satisfaction (motivation); the second group, methodologically stronger, uses inexpensive tokens linked to a fun event, offering intrinsic satisfaction (motivation).

Methodologically weak studies rely on the (small) chance of winning a (large) reward. In this instance, the prize is the *primary* reinforcer. If a site records a specified number of accident-free days a prize is drawn. These studies have been reported in American manufacturing (Czernek and Clack, 1973) and British construction (Gibb and Foster, 1996) and involved luxury car draws to promote a reduction in accidents below the industry average. The reliance solely on the prize requires very costly rewards and suffers the failings of any fixed reinforcement schedule, where a draw is made at regular time intervals, because reinforcement is strong immediately before the draw but weak for a considerable period after (Luthan, 1992), whereas variable ratio reinforcement schedules, in which the occurrence of the reward is unpredictable, rely on the fun of participation.

Methodologically strong studies use an experimental design which relies on the use of a natural *primary* reinforcer (participation in a prize draw) to extinguish unsafe behaviour/strengthen safe behaviour by the aid of a *secondary* reinforcer (opportunity to collect a token) and are often used with feedback (Zohar, 1980a, b; Fox and Sulzer-Azaroff, 1987).

Zohar and Fussfield (1981) conducted an experiment to promote the use of ear protection in an Israeli weaving factory employing 180 workers, with a similar

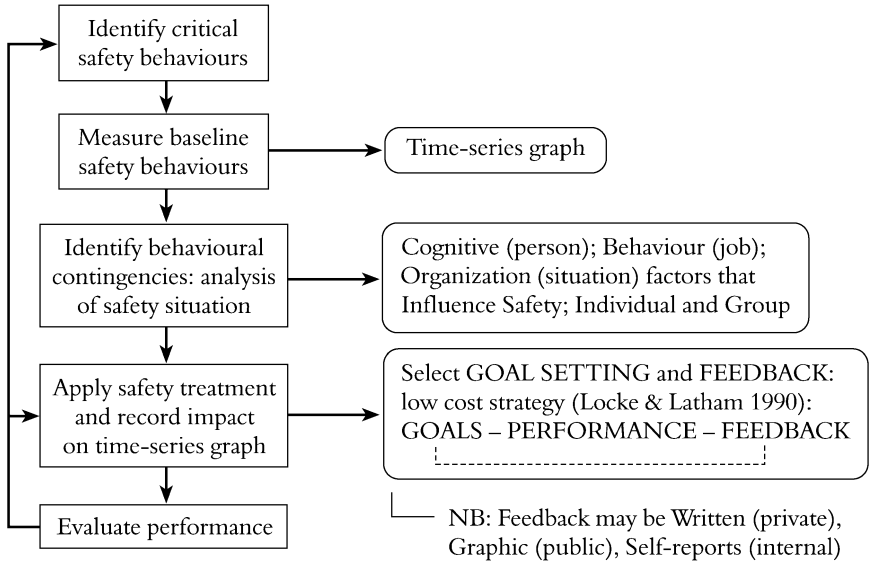

Figure 3 Behaviour change through Goal Setting: a social learning perspective (adapted from Luthan, 1982; Lock and Latham, 1984)

plant acting as a comparison. The usage of ear protection was around 35–50% in both. Tokens, which could be exchanged for products from a catalogue, were dispensed to employees observed wearing their ear protection by the plant manager during his random daily tour. Earplug usage increased rapidly in the experimental department from 35% to 90%, and was sustained during a follow-up period when tokens were withdrawn but feedback continued, whereas usage remained at 50% in the comparison plant.

A second experiment by Zohar and Fussfield (1982) was conducted in the weaving department that had served as a comparison in the previous study. Tokens of a differential, but nominal value were dispensed to groups of employees, depending on the number of workers using earplugs in each group. Earplug usage rose from 50% to 90% and subsequently remained stable throughout the three-month follow-up, using only feedback.

The significant factors in Zohar's studies include: a transition from contrived rewards (tokens) to natural rewards (feedback); peer pressure leading to revised behavioural norms, even in new workers; manager motivation to preserve behaviour change and avoid poor reflection on their competence.

Fox and Sulzer-Azaroff (1987) applied a token scheme in two mines in the United Sates during 1970–85. The study used awards of around 500 low-cost redeemable trading stamps at the end of each month for not recording a lost-time first-aid accident. Group tokens of around 500 were awarded to all members of a squad if all workers in the squad reached the goal of no accidents during the month. Special awards of around 1000 were also given by the safety committee for effective safety suggestions. A penalty of not being allowed to earn tokens for several months was applied to all group members if any individual within the group was caught failing to report an accident.

Both mines experienced a decrease in accidents: from 40 to 20 lost-time accidents and 15 to 5 lost-time accidents respectively (per million person hours per year). The longevity of the study allowed accident experience to be measured, instead of the incidence of tasks performed safely, as accidents can be a legitimate measure of safety over the very long term, provided full reporting can be guaranteed. Notwithstanding the reported effectiveness, the study appears to have done little to involve managers or promote safety as an integral aspect of a job.

A study by Sulzer-Azaroff *et al.* (1990) used goal setting, posted feedback, supervisory praise, individual tokens and group tokens to improve both the percentage of tasks being performed safely and accident experience in a telecommunications manufacturing company. During the six-month intervention phase, the 225 employees, in three departments, were set progressively more difficult safety goals, every four weeks, and received weekly posted feedback. Safety performance was regularly considered by board directors, often supporting corrective-action requests made by an implementation committee. Low cost tokens were given to individual employees when department goals were attained, with a group award of a monthly meal and social evening for '100% safe' and 'zero accidents'.

Safety scores of 90%, 99% and 100% were achieved by the three departments—an improvement of 30% in each case. Furthermore, reductions from 47 to 30 first-aid accidents and from 14 to 1 lost-time accidents were achieved.

Significantly, Sulzer-Azaroff *et al.*'s study included manager participation and executive board buy-in; and group awards promoting a team approach to safety as well as goals with feedback.

Contrived incentives

Contrived incentives is a sensitive issue. Brown (1978) suggests that contrived incentives may be necessary to promote difficult behaviours. Peterson (1988) questions their practicality in work settings and suggests incentives are 'gimmicks that trivialize safety'. Reber *et al.* (1989) acknowledge that tokens may be inevitable to revitalize goals/feedback. Krause (1995) believes that they generate under-reporting of accidents, and that one month's reward becomes the next month's entitlement, destroying pride in safety excellence. However, Brown (1978), Peterson (1988), Reber *et al.* (1989) and Krause (1995) all agree that interventions involving contrived incentives should increase their reliance on natural incentives as soon as problem safety behaviours stabilize.

Manufacturing safety initiatives using goals and feedback

North American studies

These studies depend on goals coupled with feedback for their motivational effect. Although most studies report an element of training, there are few where it is possible to isolate the effect of training (Komaki *et al.*, 1982; Reber and Wallin, 1984).

Rhoton (1980) provided individual and graphical feedback to 60 mine workers to reduce the number of ventilation citations (indicators of immediate fire risks). The baseline measurement showed the mean number of ventilation citations issued per month to be 2.6, with a mean of 13.3 inspection days per month. During the

intervention phase, there were 10 consecutive months without a citation, despite the mean number of inspection days increasing from 13.3 to 17.7 per month.

Hopkins *et al.* (1986) used supervisor-administered corrective feedback to improve air quality (e.g. activating fans and closing doors) and increase the incidence of nine self-protective behaviours (e.g. wearing respirators, covering skin and using fume cupboards). At the conclusion of the nine-day intervention air quality had improved from 160 to 90 parts of styrene per million parts of air. Seven key behaviours were improved (e.g. activating fans—100%; covering skin—40% to 80%; closing doors—50% to 90%, etc.).

The Rhoton (1980) and Hopkins *et al.* (1986) studies both demonstrate the inadequacy of engineering solutions, on their own, if they depend on worker action to deploy them. Rhoton's workers already had gas monitoring equipment and extract fans but often failed to use them; Hopkins' styrene workers had exhaust fans and fume booths but failed to use them. Hopkins *et al.* extended behavioural techniques from industrial safety to occupational health, but also demonstrated that behavioural methods have limitations. For instance, they may be unable to modify disagreeable behaviours, such as wearing uncomfortable personal protective equipment (PPE) (respirators).

Judy Komaki and colleagues have written extensively on the design of behavioural experiments (Komaki, 1982, 1986; Komaki and Jensen, 1986) as well as conducting three notable safety studies (Komaki *et al.*, 1978; Komaki *et al.*, 1980; Komaki *et al.*, 1982). Komaki *et al.* (1978) developed observations to measure safety in two departments of a bakery, using training plus goals with written and graphical feedback. They report that during the intervention the mean for incidents performed safely increased from 70% to 96%, and 77% to 99%, for the two departments respectively. When feedback was withdrawn at the end of the study, performance dropped back to baseline levels.

Komaki *et al.* (1980) designed an experiment that isolated the impact of training and goals/feedback on the incidence of safe behaviours of 55 mechanics, in four departments, at a large garage. Results for the preventative maintenance department, by far the largest (37), record that although training alone improved performance (from 50% to 60%) over baseline, goals and feedback gave further improvement (from 60% to 70%). Performance regressed to previous levels (60%) when goals and feedback were withdrawn, but returned to a high level when goals and feedback were reintroduced (60% to 70%-safe). These results were repeated in the other departments, implying that training alone is insufficient to substantially improve performance.

Komaki *et al.* (1982) investigated the role of antecedents (rules and training) and consequences (feedback) in the promotion of safety in a poultry plant containing 200 employees divided equally between three departments. Performance gradually improved across all departments, from baselines of 71%, 78% and 78%, to 75%, 83% and 90%, after implementing rules and training; and, further, to 89%, 95% and 96%, after feedback. Feedback was equally effective regardless of whether feedback was given once or three times per week. Labelling improvements due solely to 'consequences' may be misleading as it is now recognized that informal, intuitive or self-set goals may operate (Locke and Latham, 1990).

Komaki's work shifted emphasis from engineering control to human factors and stimulated much research (e.g. Komaki *et al.*, 1978). It also cast doubt on the utility of training, in isolation, as a method of promoting consistently high safety standards (e.g. Komaki *et al.*, 1980) and recognized that optimum safety performance is best achieved by the training coupled with feedback and goals (Komaki *et al.*, 1982).

Beth Sulzer-Azaroff has published extensively on behavioural safety (Sulzer-Azaroff, 1982; Sulzer-Azaroff and Fellner, 1984; Sulzer-Azaroff, 1987; Sulzer-Azaroff *et al.*, 1994), including reporting four industrial safety studies on goals or feedback (Sulzer-Azaroff, 1978; Sulzer-Azaroff and de Santamaria, 1980; Fellner and Sulzer-Azaroff, 1984a; Fellner and Sulzer-Azaroff, 1984b).

Sulzer-Azaroff (1978) used inspections by safety officers and written feedback of observed hazards, to reduce the number of mechanical, chemical, electrical and fire hazards in 30 laboratories. Improvements coincided with the introduction of feedback. The mean pre-intervention figure for all laboratories was five hazards (range 3–6) per month, reducing, during intervention to 2.5 hazards (range 1–3) per month. Twenty labs markedly improved, eight remained unchanged and two slightly deteriorated, demonstrating that simple, non-intrusive feedback can produce a sharp reduction in hazards.

Sulzer-Azaroff and de Santamaria (1980) applied feedback to improving safety performance at a custom products plant. A recording system for 18 hazardous conditions was developed and an intervention, of feedback notes congratulating good practice, designed. The feedback was aimed at supervisors who were required to discuss safety observations with their supervisees. Feedback was issued to six supervisors controlling 128 employees. The frequency of hazards decreased, and numbers stabilized, in each department when the feedback package was introduced. Hazards dropped, during intervention, by a mean of 60% across all departments, with a range of 29–88%.

Fellner and Sulzer-Azaroff (1984a) tested posted feedback on the safety performance of a paper mill employing 158 people. The mill was split into 17 zones; 31 critical safety items, a mix of conditions and practices, were identified. Fellner and Sulzer-Azaroff avoided goals and training, prior to posting feedback, in order to determine whether feedback alone could bring about performance improvements. Graphical feedback was 'rolled out' across the zones, in steps, and performance improved generally, in step with the feedback. Safe conditions improved from 79% to 85%, overall, with nine of the 17 zones improving, seven remaining unchanged, and one deteriorating slightly. Safe practices improved from 78% to 86%, overall, with 11 of the 17 zones improving. Four were already performing at a maximum, one failed to record data and one decreased.

Fellner and Sulzer-Azaroff then extended this study by the addition of goals. The intervention (feedback) phase of their 1984 study (Fellner and Sulzer-Azaroff, 1984a) became the baseline phase for a goals and feedback intervention (Fellner and Sulzer-Azaroff, 1984b). The baseline figures (feedback) recorded scores of 85% for conditions and 86% for practices. 'Tell & Sell' goals were set (specific, difficult, public) for a period of 30 weeks. Conditions improved by an average of 2.5% and practices by an average of 2.1%. Although goals improved performance, the improvements were smaller than on the introduction of feedback, in absolute terms.

Statistically, feedback effects were significant but the subsequent addition of goals failed to reach significance (at the 5% level). This was possibly due to ceiling effects, as statistically significant improvements are difficult to achieve from such a high baseline.

The main achievements of the Sulzer-Azaroff studies are that they demonstrated that simple written feedback can improve safety practices; that posted feedback can achieve improvement without training; that goals and feedback, together, can improve safety performance over feedback alone (Sulzer-Azaroff, 1997).

Jerry Reber and colleagues have reported two important studies. The first (Reber and Wallin, 1984; and Reber *et al.*, 1989) was a study to assess the relative effectiveness of three different, successive interventions on the safety practices of three groups, totalling 105 employees, at a farm machinery plant. The interventions were: training; training with assigned goals; and training with goals and feedback. Thirty-seven items (e.g. protective equipment, housekeeping, manual handling, tools and equipment) were measured. The results for all three groups were: a mean safety score for the baseline phase of 62% (range 56–72%); a mean score of 71% (range 60–80%) for training only; a mean score of 78% (range 72–90%) for training and assigned goals; and a mean score of 95% (range 90–98%) for training and goals with twice-weekly feedback. Also, better safety scores were associated with reduced accident rates, from 85 incidents per 100 employees per annum to 55 per 100 employees during the year of the study.

Chokkar and Wallin (1984a) and Chokkar and Wallin (1984b) reported a component analysis, with training held as a constant, to test the superiority of goals *versus* goals and feedback on the safety performance of 58 metal workers. The research used a procedure (Reber and Wallin, 1984) to design an inventory of critical behaviours (eyes, face, hands, tools) and situations (passages, stacking, equipment). The differential effects of three treatment combinations were evaluated: training with goal setting; training with goal setting and weekly feedback; and training with goal setting and fortnightly feedback. The results again demonstrated that goals and feedback are more powerful than goals alone when training is a constant. The results also demonstrated that fortnightly feedback can be just as effective as weekly feedback.

The significance of these studies is (Chokkar, 1987): first, they tested classical goal theory in the field of safety, using Locke's principles of difficulty, specificity and knowledge of results (feedback). Reber's experiments show that goals are not fully effective in improving safety, unless they are difficult, specific and feedback is present; second, Reber *et al.*'s (1989) research suggests that a negative relationship exists between behavioural safety measures and injury rates; and third, Chokkar and Wallin's (1984a, b) work suggests that fortnightly feedback may be equally as effective as weekly feedback. This is important for potential transition to a 'maintenance phase': an ideal objective for a behavioural safety programme, in which a low frequency intervention will endure over the long term.

European and Middle-East studies

Dov Zohar and colleagues attempted to promote the use of ear protection in an Israeli metal fabrication plant, comprising two departments employing 80 and 82 workers respectively (Zohar *et al.*, 1980). Employee turnover was about 65% per annum which made it especially difficult to persuade employees to wear ear protection, despite high noise levels. Previous initiatives, including lectures and discipline, had failed. Ear protections had been measured at 35%. An intervention of individual feedback in one of the departments was attempted, with the other as a comparator. Workers underwent audiometric testing at the start of the shift and at the end, on two occasions, one without wearing ear protection and one with. On each occasion,

the differences between the two were explained as noise-induced temporary threshold shift and one copy of the audiogram was given to the employee and another posted on a bulletin board. After this two-month audiogram phase, a five-month observational phase showed that earplug usage increased from 35% to 85%. Earplug usage remained constant at around 35% in the comparison department. Zohar *et al.* also reported that new workers also now wore earplugs. New group norms had developed. It seems that it is possible to motivate employees to wear uncomfortable ear protection by using individual feedback on hearing loss and that these procedures need not be applied to every new worker, once the organizational climate has changed.

More recently, Zohar and Luria (2003) have extended the safety interventions of goal setting and feedback to include supervisory and line management behaviour. In three parallel studies of safety performance in an oil refinery, a food manufacturing plant and a milk processing plant, feedback and personal goal setting were used to improve the safety focus of interactions between shop-floor supervisors and workers. Very short questionnaires were administered to workers and the results, the frequencies of interactions with supervisors in which workers recalled that safety was a subject of discussion, were fed back to supervisors and line managers. Based upon this feedback, personal improvement goals were set for the supervisors. At the same time, observations were made of safety behaviour. In all cases, over a four-month period, significant improvements in both the frequency of safety interactions between supervisor and worker and safe behaviour of workers were recorded. Senior management were also given feedback, in order to promote a positive attitude to the intervention and encourage the modification of prescribed supervisory roles to include a greater focus on safety, which resulted in clear long-term improvement.

Saari and colleagues conducted three behavioural safety, or motivational, studies (Saari, 1987; Nasanen and Saari, 1987; Saari and Nasanen, 1989; Saarela, 1990) and two related informational, attitudinal studies (Saarela *et al.*, 1989; Saarela, 1989).

Saari (1987) describes a motivational study to improve housekeeping standards in a Finnish margarine manufacturing plant employing 15–20 workers in each of two departments. Accident experience had suggested that musculoskeletal injuries, due to slipping, tripping, and stepping on objects, were the major source of lost work days. In the study 14 causal, housekeeping situations (e.g. clear gangways, clear fire exits, stacking of materials) were evaluated. The results showed housekeeping improvements at both departments, after a series of interventions: training and posters; posted feedback; and feedback withdrawal. In each case, even after feedback was withdrawn, scores improved, leading to a total improvement of more than 20%. As performance improvements remained, despite the withdrawal of feedback, Saari concluded that the environment (plant safety culture) itself began to convey feedback.

Nasanen and Saari (1987) next conducted a series of experiments, at different yards of a Finnish shipbuilder, to improve housekeeping in a single department employing 32 shipyard workers. An inventory of nine critical practices was developed for assessment. The intervention phases were: training slides followed by written feedback to foremen; public feedback to operatives; and a follow-up phase with no treatment. Goal setting was not encouraged; however, some foremen set their own goals of 85% and some operatives believed that 100% was the goal. Mean performance improved from 62% to 75% for training and feedback to foremen, to 88% for public feedback, and remained steady at 84% during a 10-month follow-up period. Saari concluded that feedback was the agent of change and that the higher standard achieved produced a change in workplace norms during the follow-up. Also, all-accident index of 16–21 for the preceding three years reduced to five accidents during the year of the experiment. Saari and Nasanen (1989) later reported, for the three years after the interventions, that the housekeeping index remained over 80% (84%, 84%, 82%) and the all-accident index reduced to 5, 1 and 8. This suggested that employees learned to generalize their enhanced safety consciousness.

These results should be contrasted with attitudinal studies conducted by the same research team. Saarela *et al.* (1989) conducted a campaign to improve housekeeping standards at a Finnish shipyard, by locating posters containing safety slogans on housekeeping at visible locations throughout the workplace. The results demonstrated that, although they could be recalled by workers, no recordable change occurred in safe employee behaviour or accident experience. A parallel poster study at a neighbouring shipyard, attempting to improve scaffold safety, gave similar results. Saari's (1990a, b) review of their behavioural and attitudinal shipyard research concluded that there was considerable evidence to support the use of motivational campaigns based on feedback but little evidence to support the use of campaigns based on posters.

The significance of Saari's research is: first, that housekeeping and accidents can be improved over long periods by feedback; second, a tidier environment can generalize to other aspects of work safety and perhaps explain why interventions can remain effective for several years; third, interviews suggested that employees valued the initiative and it is debatable whether

prolonged behaviour change could have been effected if the study was seen as merely an experiment; fourth, poster campaigns raise hazard awareness but are unlikely to modify risk-taking behaviour.

Cooper and associates conducted a goal-setting and feedback initiative within a British cellophane manufacturing plant (Cooper *et al.*, 1993a; Cooper *et al.*, 1994) to improve housekeeping, use of protective equipment, safe use of plant and stacking of materials. The factory employed 540 people across 14 departments, 48 of whom were recruited as observers. The intervention comprised training of observers in use of a checklist type of measure, followed by group goal setting and posted feedback. During the intervention researchers were on site for two days per week, but during maintenance, they were only on site for one day per month because the plant workers operated the programme themselves. Plant safety improved from 52% to over 70%, after the first four weeks of the intervention, averaging 68% for 16 weeks after the withdrawal of the intervention. Accidents fell from 172, during the previous year, to 44, during the year of the study, and measures of safety climate also improved (Phillips *et al.*, 1993; Cooper and Phillips, 1994).

The significance of Cooper *et al.*'s study is: first, it was the first occasion that goal setting was used to enhance safety in UK manufacturing; second, ownership of the programme passed from researchers to workers, importantly because the longevity of a behavioural safety intervention can only be assured if workers learn to, and wish to, implement the method themselves; third, the study demonstrated that behavioural safety can contribute to a positive safety climate, addressing attitudes and behaviour concurrently.

Safety initiatives using goals and/or feedback in construction

Behavioural safety studies have been less prevalent in construction. Studies using goals/feedback have been conducted by the following teams of researchers: Mattila and Laitinen (Mattila and Hyodnmaa, 1988; Laitinen and Ruohomaki, 1996) in Finland; Duff and colleagues (Duff *et al.*, 1993; Robertson *et al.*, 1999) in Britain; and Lingard (Lingard, 1995; Lingard and Rowlinson, 1998) in Hong Kong.

Mattila and Hyodnmaa (1988) set behavioural targets and provided written and graphic feedback in relation to these targets on two sites belonging to a Finnish national construction contractor. The first was a precast concrete office development, employing 100 operatives and 10 foremen; the second was a steel frame and brick apartment house, employing 20 operatives and three foremen. The sites identified six critical performance items. An intervention of written feedback to foreman was followed by a further intervention of graphic feedback and posted safety targets. Performance on both sites improved by 10% with feedback to foremen, and a further 4% with graphic feedback to operatives and posted goals. The safety index on comparator sites remained at around 60%.

Mattila's research was the first occasion that goal setting and feedback had been applied to construction safety and one of the first behavioural safety experiments in a European culture.

Laitinen and Ruohomaki (1996) applied feedback and goal setting to improving safety behaviour of workers on two building sites, an office block and a two-apartment house. A baseline measure of performance related to eight safety rules (e.g. PPE, housekeeping, opening and railing hazards) was taken, followed by an information and goal-setting meeting. Goals of 80% were set and measurements and graphical feedback continued. Significant improvements, from 60% to 89% on Site 1 and from 67% to 91% on Site 2, were recorded. These improvements were maintained during all phases of the projects.

Duff and colleagues implemented goal setting and feedback as part of a UK Health and Safety Executive two-phase study. Phase I (Duff *et al.*, 1993; Duff *et al.*, 1994) was implemented by the researchers themselves on six sites near Manchester. Phase II (Marsh *et al.*, 1998; Robertson *et al.*, 1999) was implemented by contractors on 22 sites around Manchester.

A 10-point 'proportional-rating-scale' was used. Items were scored between 0 and 10 and then converted to a percentage (Phillips, 1992; Cooper *et al.*, 1993b), making the measurements more sensitive than the 'all-or-nothing' scales used in some other research (e.g. Laitinen and Ruohomaki, 1996).

The Phase I research used four measures of performance—housekeeping, scaffolds, access-to-heights and PPE—each containing six items of measurement (Phillips, 1992). A variety of protocols was used: a plastics factory employing 140 workers and a new hospital ward employing 140 workers received monthly goal setting and weekly feedback; a retail development employing 300 workers and an apartment block employing 130 workers received initial training, monthly goals and weekly feedback; a city centre office development employing 60 workers and a city centre bank employing 60 workers received training and feedback only. The PPE item was used as a control (receiving no treatment). In each case, the intervention was applied for two separate periods, with a period of withdrawal in between.

Results for the six sites showed that performance improved by more than 5% for 14 out of the 18 items on which the interventions took place, with large variability, but no significant improvement, in the PPE measure. Goals and feedback were the most effective; training and goals/feedback were the next most effective; and training and feedback alone were the least effective. However, it was clear that there were different levels of management commitment to the whole experiment, on the various sites; so, these measures of relative success should be viewed with some caution. Management commitment was recognized as a possible moderating factor and measured explicitly in the Phase II experiments.

The second intervention appeared to have no effect, possibly because operatives appeared dissatisfied by the removal of feedback, realizing that the process was only an experiment.

The objectives of Phase II were threefold (Marsh *et al.*, 1998; Robertson *et al.*, 1999): (1) investigate whether goal setting could be used to improve safety by construction companies, without researcher involvement; (2) measure the effects of applying the technique over longer periods of site activity—40 weeks or more, depending on the project duration; and (3) evaluate the impact of management commitment on goals and feedback effectiveness. The research was carried out across 26 construction sites, employing between 15 and 300 workers. On this occasion, all projects used a before and after experimental design with no reversal phase and no control item. Performance, measured by trained staff from the construction companies, included: housekeeping, scaffold, access to heights, PPE, and on civil engineering projects, plant operation. Monthly goal setting and weekly feedback, on this occasion supplemented by verbal annotation to explain significant changes in performance measures, were used.

Goal setting and feedback was effective when implemented by contractors with management committed to its introduction; it was maintained and effective throughout the duration of construction projects; and the degree of effectiveness was highly correlated with measures of management behavioural support. Seven interventions folded with insufficient data collected; nine showed no significant change; and 10 demonstrated real improvements. Average improvements for the 19 completed sites, including poor results from several with low management commitment, were: housekeeping 80–82% (a rise of 2%); scaffold 83–90%; access-to-heights 86–90%; PPE 77–85%; and plant 85–88%.

Parallel research (Wall *et al.*, 1994) suggests that expressed management commitment ('positive attitudes') is unimportant, provided that managers act conscientiously. Marsh *et al.* (1998) suggest that sites identify a management 'champion of the intervention' who steers the safety intervention throughout the contract.

Lingard (1995) adapted the methods of Duff *et al.* to suit the peculiarities of Hong Kong construction. Scaffold became 'bamboo scaffold' and roofwork items associated with tall buildings were further developed (Lingard and Rowlinson, 1994). The seven test sites were all high rise housing blocks employing several hundred operatives. Results of the study were very mixed, suggesting that overall there was no improvement in safety: bamboo scaffold was unchanged and access-to-heights improved at only two sites. However, housekeeping improved across all seven sites, from a 'before' mean of 62% to an 'after' mean of 77% (Lingard and Rowlinson, 1998). When the researcher-led intervention had occurred, the contractor declined to maintain goal meetings or feedback graphs. However, the researchers continued measuring for a further four weeks (heights) and eight weeks (housekeeping).

It appeared that employees could work together to improve housekeeping because this did not require additional materials or equipment, whereas improvements in access-to-heights or bamboo scaffold were beyond the control of most operatives, because often there were inadequate materials on site to construct a safe working platform (Lingard, 1995). Hence, for access-to-heights and scaffold, Lingard's study did not test the goal-setting hypothesis. For behavioural safety to work there must be a developed 'safety infrastructure' (Lingard and Rowlinson, 1998). Further, the more effective sites (sites one and five) were the sites where goal-setting meetings were attended by the project managers and the worse sites (sites six and seven) were the sites where senior managers failed to attend. Lingard's experiences, therefore, appear similar to Duff *et al.*'s findings: that visible management support is essential if interventions are to succeed.

The significance of these construction behavioural studies is: first, Duff *et al.*'s research was the first UK goal-setting project to improve safety on construction projects, enhancing the validity of the method in construction through the use of a proportional rating scale; second, Robertson *et al.*'s research was a large scale study covering over 20 sites, and the first of its kind to be implemented by industry, highlighting the large effect of management commitment; third, Lingard's research extended behavioural safety to the dangerous Hong Kong construction industry, demonstrating that the method can help to improve safety in such an environment, provided that contractors have a

developed safety infrastructure, appropriate resources and management commitment.

A critique of behavioural safety

Benefits, limitations and pitfalls

There is a compelling body of evidence to support the utility of behavioural safety in manufacturing industries and a growing body of evidence to support the use of these methods in construction. Although benefits can be identified, limitations also exist. And, where these exist, potential pitfalls can be found.

Benefits

These may be summarized, thus:

- studies demonstrate improved standards of safety performance across items that are related to accidents, by the proactive use of data as feedback rather than as a record of events that occurred in the past (Komaki, 1986);
- the behavioural approach avoids the weakness of poster-style propaganda (Sell, 1977);
- behavioural safety involves and empowers workers (Cooper, 1998);
- worker participation is often accompanied by improved safety communications between operatives and managers (Cooper *et al.*, 1994; Cooper and Phillips, 1994).

Limitations

These may be summarized, thus:

- behavioural safety based on goals and feedback is unlikely to improve safety if an employee lacks the basic skills to perform a task safely (Sulzer-Azaroff, 1987);
- behavioural methods are unlikely to be effective if the organization lacks appropriate materials and equipment (Lingard, 1995);
- the methods may be perceived, at least in construction, as time consuming or complex which is possibly limiting the use of the method at present (Cameron, 1997).

Possible pitfalls

These include:

- behavioural safety programmes tend to concentrate on the 20% of most frequently occurring items that account for 80% of accidents, possibly resulting in insufficient attention to deficiencies that are less likely to occur but have potential for catastrophic loss;
- failing to involve subcontractors and thus only 'preaching to the converted' (Hale and Glendon, 1987; Marsh, 1995);
- resistance to such initiatives is very likely (Reber *et al.*, 1989), but manageable (Cooper *et al.*, 1993a); and
- most important of all, failing to ensure the commitment of the site manager, without whose support the intervention will very probably fail (Marsh *et al.*, 1998; Robertson *et al.*, 1999).

It is also important to retain a sense of perspective. The behavioural approach is not a panacea; rather, the approach is best considered as a component of an integrated safety strategy encompassing human factors, engineering control, and legislation (Chokkar, 1987).

Conclusions

There are three different behaviour change perspectives, to explain the effects of goal setting and feedback: a cognitive explanation (goal setting); a behaviourist explanation (behaviour modification); and an eclectic explanation (social learning). Bandura's social learning theory helpfully integrates the seemingly divergent philosophies of Locke's goal setting and Luthan's behaviour modification, adopting the premise that behaviour is controlled by both internal processes and environmental stimuli. Therefore human action is best explained, and influenced, by the combined effect of goals and feedback.

The consistent finding to emerge from the literature is the effectiveness of behavioural safety, though, despite some encouraging results, token economies remain controversial because they are close to 'paying for safety'. Past researchers have overwhelmingly favoured behavioural initiatives based on goals and simple performance feedback, without material rewards.

Goals and feedback (sometimes bolstered by training) have been used to produce good results in the varying cultures of North American, European and Middle-East manufacturing environments, including mines, chemical plants, laboratories, paper mills and shipyards.

Goals and feedback have, more recently, been used to improve safety behaviour in the Finnish, British and Hong Kong construction industries. Additional findings are that their effectiveness is strongly related to management commitment and they must be supported by a sufficiently developed safety infrastructure.

It is clear that, though behavioural safety interventions can be extremely effective, they rely very much on the active support of a committed management. The

conclusion to be drawn is that a behavioural intervention, focused on both management behaviours and operative behaviours, might encourage committed management behaviour, in support of a proven method of reducing unsafe operative behaviour. Such an approach will be described in a subsequent paper.

A possible risk of behavioural safety initiatives is a narrow focus on the content of performance measurement checklists, embracing frequent failures but missing other, less frequent but high risk factors. They, also, invariably represent some organizational change, and can meet resistance. Behavioural safety is not a panacea, and the best results are likely when the method is applied to both management and operative behaviours and used in conjunction with effective engineering controls and safety infrastructure.

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