COMMUNICATION OF SAFETY IN THE DESIGN PHASE

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Ineffective management practices, particularly in the design phase, have been identified as a prime cause of the unacceptable accident and occupational health record of the construction industry. The Construction (Design and Management) Regulations requires designers to identify, reduce and control risks to the workforce. However, for many designers the adoption of such practices is still unfamiliar and there is little information on procedures or best practices. Thus, to a large extent the application of such regulations is intuitive and relies on the attitude and behaviour of the designer and their ability to communicate the identified risks effectively. This paper outlines the methodological approach to be used in measuring the attitudes, beliefs, and behaviour and value judgements of the parties involved during the design phase.

Keywords: behaviour, communication, design, health, management, safety.

INTRODUCTION

The requirement for increasingly complex projects, more exacting demands in terms of time, cost and quality, fluctuating industry workload and ever tighter fee scales have focused the need for effective communication and management of information during design. Numerous government and stakeholder-sponsored studies on the culture and operation of the UK construction industry have been conducted. These reports have acknowledged that communication and information flow during design have a major impact on the performance of construction projects. Back in 1962, Emmerson stated that "in building there is all to often a lack of confidence between architect and builder amounting at worst to distrust and mutual recrimination. Even at best, relations are affected by an aloofness which cannot make for efficiency, and the building owners suffer. In no other important industry is the responsibility for design so far removed from the responsibility for production". The Banwell Report (1964) found that "insufficient regard is paid to the importance or value of time and its proper use in all aspects of a project, from the client's original decision to build, through the design stages and up to final completion. Time well spent can mean time and money saved". Faster Buildings for Industry (1983) acknowledged that the design must account for buildability and that specialist consultants and contractors with design input must be properly co-ordinated as soon as is reasonably practicable. Work on site must be based on full information, communicated clearly and in adequate time. This is facilitated by high levels of site management with strong links with the design team and client. The report also found that the form of contract does not primarily determine performance but the attitude of the contributing parties may. However, the notion of complete or full design at tender stage exposes a fundamental lack of understanding of the design process. Early appointment of all specialist resources would generally prove too costly both in terms of design fees and contractual risk. The Latham Report (1993) suggests clients must allow adequate time for the preparation of

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the brief and should seek advice. " Even the best clients are likely to benefit from some advice on alternative methods of achieving their aim, which may produce better value for money". In relation to the design process, Latham noted that "effective management of the design process is crucial for the success of the project". Lack of sufficient management during the design phase results in insufficient information for completing designs or resolving conflicting construction details.

The most recent industry review titled "Rethinking Construction" once again acknowledged the problems that underpin the industry. In its assessment of design the Egan Report (1998) identified a number of shortcomings, which included:

> *"too much time and effort is spent in construction on site, trying to make designs work in practice.... which is indicative of a fundamental malaise in the industry - the separation of design from the rest of the project process."*
>
> *"there has to be a significant re-balancing of the typical project so that all these issues are given much more prominence in the design and planning stage before anything happens on site"*
>
> *"designers should work in close collaboration with the other participants in the project process. They must understand more clearly how components are manufactured and assembled."*

DESIGN RESEARCH

Considerable research resources have been dedicated to improving performance during the construction phase, both in terms of management and construction techniques. This is a marked contrast to the work aimed at improving performance during the design phase. Similarly, until recently, safety had only been administered during construction with little consideration given to safety during design. This imbalance is partially explained by Edlin (1991) who suggests that because the design stage only accounts for 3-10% of the total project cost the greatest savings, in financial terms, can be most easily made by concentrating on improving construction efficiency. However, the relatively small cost of design compared to construction belies its true importance to the project as a whole. Galvin (1991) showed how many design-related problems drastically affected construction performance. The importance of improved design management has been widely recognized (Austin *et al.* 1993, 1994, 1995, Grey *et al.* 1994). A report by NEDC showed that more than fifty per cent of problems on building sites were related to poor design (NEDC 1987). More recently, a study by Boudjabeur and Skitmore (1996) found that in a survey of design and build managers, client and information related factors were the most frequent and had the biggest impact on the performance of construction projects. These problems are the probable root cause of many of the accidents and near misses experienced by the industry. In summary, these reports have identified good practice which has long been advocated but rarely followed. It is depressing to read the Emmerson Report and the Banwell Report to find that the 'same' problems persist a generation later. While there is "a widespread acceptance that change is necessary, and that it is long overdue" (Latham 1994), the culture change that the industry is waiting for is not evident.

No accidental trend

Over the last twenty-five years the UK construction industry has witnessed a steady decline in the number of fatal and non-fatal accidents. Unfortunately statistics for 1996/97 saw an increase across the range, with fatal accidents up 12.2 % and

Table 1: Employment / accident comparison

	Construction employees as a % of the working population	**Construction fatalities as a % of all work-place fatalities**
UK HSE 1998	5	12
Europe Bishop 1993	10	30
United States Ehmer and Jaselskis 1998	5	20
Japan Watanabe and Hanayasu 1999	10	40

major/non-fatal accidents up nearly 17.5 % on previous annual figures (HSE 1998). Provisional figures for 1997/98 suggest that once again fatalities may be on a downward trend. Whether the increase was a 'sinister blip' as a result of the increased workload or better reporting as a result of more stringent legislation, remains to be seen. Differing measuring criteria hampers international comparison. However, research suggests that the European construction sector account for thirty percent of all fatal workplace accidents while employing less than ten percent of the working population (Bishop 1993). Similarly the US construction industry accounts for twenty percent of workplace fatalities while employing five percent of the labour force (Ehmer and Jaselskis 1998). Surprisingly Japanese construction, which is often applauded for it's managerial practices, accounts for forty percent of all workplace fatalities (Watanabe and Hanayasu 1999). (see Table 1)

Until recently most emphasis had been placed on analysing the construction phase, where it was commonly perceived accidents had their root causes. Previous research into design management, some of which has been summarized in this paper, suggests there is considerable scope for improvement in analysing procedures in the pre-construction phase in order to reduce the risk of accidents. While fatalities and major injuries are a rare occurrence, it makes it difficult to distinguish random incidents from developing trends. As the system of measurement is reliant upon failure, a long incident-free period suggests effective implementation of safety policy. This problem is acknowledged by the HSE, "a low accident rate, even over a period of years is no guarantee that risks are being effectively controlled, and will not lead to injuries, ill health or loss in the future. The historical incidence of reported accidents can be an unreliable, deceptive indicator of current and future safety performance" (HSE 1992). Another limitation on the use of reactive monitoring is that chronic health problems are not identified until it is too late. There is also the problem with the accuracy of the recorded data. Under reporting of accidents and incidents is a major problem within safety management. Anderson (1992) suggested that employers report only 40% of all accidents, and that the self-employed report less than one in ten. Also until the recent introduction of legislation (RIDDOR 1995), accident reporting suffered as a result of inconsistent and uncoordinated reporting, resulting in missing and inaccurate information. Thus, although accidents appear to be falling, underlying issues suggest a need for greater concern.

Unusually construction workers have little creative input into the products they produce. They contribute to neither the design details they are asked to follow; the choice of materials which they have to work with, the programme time-scale or sequence; or the macro market forces that in turn determine amongst others, remuneration. They have, in effect, a devolved input and control over their work.

Contractors are reliant upon a hierarchical system of management that has, over a period of years, consistently reduced their ability to control the environment in which they work. Yet within this framework they are deemed to control and are held responsible for their own safety. This viewpoint has been conveniently paraphrased:

- Clients Have information on risk
- Designers Introduce Risk
- Contractors Manage Risk
- Workers Endure Risk (Bacon 1999)

Designing for safety

'Prevention is better than cure'. This well-known proverb suggests that the best way of preventing an accident is by eliminating the possibility of it taking place. The reduction of risk should begin with the conception of a new building, designing intrinsically safe and easy to build projects. A report entitled 'Blackspot Construction' (HSE 1988) concluded that positive action by managers within the UK construction industry could have prevented 70% of the fatalities. One of the main causes identified was the lack of co-ordination between the professional team members at the design stage. A survey in South Africa by Smallwood (1996) found that fifty percent of respondents identified design as a factor to negatively affect safety. These views are supported by the pre-amble to the European Temporary and Mobile Sites Directive (1992) which suggests that unsatisfactory organizational options and poor planning at the preparation stage of projects influenced more than half of the accidents occurring on construction sites in the community. The root cause of accidents can be broadly split into three classes: those due to design decisions, those due to lack of planning and those due to construction methods and processes. A study by Churcher and Alwani-Star (1996) found that sixty three per cent of fatalities are traceable to pre-construction activities. Jeffry and Douglas 1994 also found similar results. Studies by Barnard (1996) and Hinze (1992, 1998) have emphasized the role of safety in design. However, before safety information is implemented, designers must be willing to use it. Gambatese (1998) argues that by incorporating safety knowledge, a designer's exposure to liability increases, which may deter the designer from implementing knowledge. "Traditionally in the United States, unless specifically written into a contract, a designer is not responsible for overseeing construction worker safety." (Gambatese 1998). Blockley (1999) further addresses the ethics of engineering safely. The early stages of design are particularly important. In complex decision-making situations the ability to affect project outcomes diminishes exponentially over time. Brandon (1978) suggests that, by the time sketch design is formulated, the major decisions affecting management costs, structure, envelope and quality standards have been made and the ability to influence remaining decisions is probably limited to twenty percent of the final cost. It is highly probable that this is also true of safety. If we accept that safety, like quality, can not be 'inspected' into a project and that 'bolt on' safety measures are seen as a reaction to potential hazards then surely safety must be implemented in early design. However, this is not merely an oversight, information is traditionally scarce during the early stages of design, in some cases, information is simply not available.

Antecedents to the research

The Construction (Design and Management) Regulations 1994 (CDM) were introduced in March 1995 as the UK's response to EC Directive 92/57/EEC, in an attempt to address the absence of safety management during the pre construction phases. As a result, regulations that legislate to ensure health and safety is co-

ordinated and managed effectively throughout a project's life cycle have been enforced for the last four years. However, for many designers, the adoption of such practices is still unfamiliar and there is little information on procedures or best practices. A recent report entitled "Experiences of CDM" (CIRIA 1997), found that many designers are unsure of their duties and the extent of risk assessment required and that as a result, the practices of designers are affected by their lack of familiarity with the requirements. " There are undoubtedly problems in understanding and applying the regulations and as yet, only a minority of participants are fully competent at their roles" (CIRIA 1997). More concerns about the implementation of the CDM Regulations quickly emerged and a study was commissioned by the HSE (1997) to examine the impact of the regulations. The principle conclusion was that the regulations had led to an increase in awareness of health and safety issues and that the Health and Safety Plan was an important and useful document. However, the lack of knowledge of construction materials, processes and techniques used in the industry is of major concern. This is compounded by the inability to identify and eliminate risks.

Associated with the introduction of the CDM Regulations is the necessity to keep abreast of new and revised health and safety legislation, for in designing safely and being able to carry out risk assessments, designers will now need to know the parameters which govern work tasks, operations and materials used. This is no small accomplishment for since their introduction numerous regulations, approved codes of practice and revised statutes have been implemented, not to mention new materials each of which have particular handling characteristics and COSHH requirements. It is hardly surprising therefore that some in the industry have been slow to adopt such practices. Thus, to a large extent the application of such regulations is intuitive and relies on the attitude and behaviour of the designers towards safety and their ability to communicate the identifiable risks effectively. Atkinson (1998) who carried out an empirical study of 107 UK construction industry practitioners found that communication was the highest rated factor to affect human error. He further suggested that a comprehensive examination of patterns of communication is required. Similarly in a detailed survey of 38 construction companies in Hong Kong, Wong *et al.* (1999) found that communication was the most important factor affecting safety performance on construction sites and second most important affecting the company as a whole.

In summary the 1997 CIRIA report indicates that there is increased awareness of H&S issues as a result of increased planning, control and behavioural changes. There was however no substantive evidence of improved health and safety. In positive reflection the report's claim that it is too early to tell, may prove to be right. Although time will not address the reluctance and apathy of some parties to acknowledge the role of safety in design. The writer agrees with the views of Clark (1998) that the key to the regulations lies in continuous design assessment and the planning supervisor's ability to ensure designers co-operate and communicate with each other.

LEGISLATION AND FINES

If the risk of accidents and their associated costs in lost time and insurance premiums, are not a sufficient motivating factor, then a Court of Appeal ruling made in November 1998 may encourage all within the construction industry to reappraise their practices. It recommended that in future, fines must be large enough to impact on those who manage a company (and their shareholders). Whilst fines should avoid the risk of causing bankruptcy there may be cases where an offence is so serious that the

Table 2: Average fines imposed per industrial sector (HSE 1998)

Sector	**Construction**		**Manufacturing**		**Service**	
Year	1993/94	1997/98	1993/94	1997/98	1993/94	1997/98
Average Fine	£3384	£3173	£2973	£5895	£3939	£5726
No.of Convictions	415	533	585	432	217	212

defendant ought not to be in business. This precedent could hit the construction industry hardest, where until recently fines were relatively low.

In the construction sector although the number of convictions has increased, the average fine imposed has decreased. The reverse of which is true for both the manufacturing and service sectors. The actual implications in the short term are that more cases will be refereed from magistrates courts to higher courts, where in addition to higher fines, prison sentences can be imposed. The Ramsgate Walkway collapse and Heathrow tunnel collapse are high profile cases where stiffer penalties have been levied.

RESEARCH DESIGN AND METHODOLOGY

Little is currently known of the determinants of safety in design and the reasons for the apparent lack of communication within the design stage. In order to address such issues the research design should adopt a logical sequence that connects the data generated by the enquiry to the study's initial research question and ultimately its conclusions (Yin 1989). Simister (1995) who suggests that research design should establish four aims provides one such sequence:

1. Make explicit the questions and research should answer
This enquiry will address the following questions:

Q1. How are safety issues communicated during the design phase?

Q2. What forces affect the communication of safety?

Q3. How effective is the communication of safe design issues to site.

Q4. How important are health and safety issues to the design team.

2. Provide hypothesis / propositions about these questions
The principal hypothesis is:

"When health and safety issues, associated with the construction and maintenance of building projects are appropriately addressed and communicated during the design phase, higher levels of construction health and safety will be attained."

In order to substantiate the hypothesis the following objectives have been set:

- To investigate the patterns of communication and responses (behaviour) during the design phase of construction projects which emerge in relation to the implementation of safety.
- To investigate the forces (factors) which create those patterns.
- To assess the importance (value) attributed to safety by designers in relation to other performance criteria.
- To determine the times and frequency during the design phase when safety is considered.
- To construct a theory of safety communication during design which will provide a valuable basis for further investigation.

3. Develop a data collection methodology

A comprehensive literature search reviewed related books, professional journals, conference papers, and publications concerning the nature and management of design, generation and dissemination of information and current health and safety design techniques. On the basis of information developed through the literature search, an exploratory questionnaire was utilized to carry out semi-structured interviews with professional design team members. The findings of the study (Mackenzie *et al.* 1998) support the concerns raised earlier, they also suggested that the most important criteria for the design team were: Level of specification; Suitability of Purpose and Date for completion. The study confirmed that safety is not a critical issue for the design team. The literature review and exploratory study supported the need for greater enquiry.

To investigate the patterns of communication and responses during the design phase of construction projects, a case study approach will be adopted. The communication of safety occurs naturally during the life of a construction project and as Yin (1984) points out, case studies provide a richly detailed longitudinal portrait of a particular social phenomena in a real life context. Schramm (1971) expounds that the essence of a case study is to highlight a decision or set of decisions; why they were taken; how they were implemented and with what result. Due to the restrictive sample size it is important to accept that this method of enquiry will not provide representativeness of the wider population. However Sudman (1976) argues that confidence in the robustness of case study research findings increase with the number analysed. To alleviate the potential subjectivity associated with recording and interpreting the case study data, triangulation will test validity, Flick (1992). This scenario involves qualifying the facts generated by the case study with the use of interviews. Upon completion of the case study report a member of the project team will qualify that the events portrayed is a true and accurate representation of the facts. Communication data will be collected with the use of diaries. Design team members will be asked to complete their diaries by recording all formal and informal communication they have in relation to health and safety. Diaries will be periodically cross-checked to develop chronological patterns of communication between project team members. The diaries will also reflect timing and frequency of communication. Data will be elaborated by participant interviews, observation and document analysis. This methodological approach was successfully utilized by Loosemore (1996) when investigating communication of construction crises.

In order to investigate the behaviour which leads to the dissemination and communication of safety the study will adopt an ethnographic approach in order to understand the cultural context of behaviour and the symbolic meaning and significance of the behaviour within the context. Ethnography means describing a culture and understanding a way of life from the point of view of its participants. Sociocultural knowledge held by social participants makes social behaviour and communication sensible. Therefore a major part of the ethnographic task is to elicit that knowledge from informant participants" (Spindler and Spindler 1992). Data collection in ethnography may use several techniques, typically focusing on things that happen again and again. Closure is achieved by recognizing the point at which nothing new about its cultural significance is learned. It is envisaged that this line of enquiry will establish the importance attributed to health and safety in design, the timing of its inclusion and the type and level of risk analysis carried out.

In order to corroborate the case studies data, a survey of sixty design team members will be carried out to ascertain the representativeness of the findings. The study will

adopt the "Process Protocol" (Time Research Institute 1998) as the framework within which to carry out the enquiry. The Process Protocol is a development of the RIBA Plan of Work, which is more able to adapt to newer forms of procurement.

4. Discuss data in relation to initial questions and hypotheses/propositions
The case study data and ethnographic enquiry will be analysed using a qualitative software package e.g. NUD*IST or NVivo. The data generated by the case studies will enable the communication patterns to be realized and the forces that create those patterns. The survey data will be analysed using a statistical software package i.e. SPSS or Statgraphics. It is envisaged the data generated will indicate: the importance attributed to health and safety in design; the timing of its inclusion in the design phase and the type and level of risk analysis carried out. Any unanswered propositions will be opinioned and all conclusions will be drawn from the research study.

CONCLUSIONS

There has been much literature published in relation to health and safety in the construction industry. More recently, attention has been focused on the design phase, where early implementation has been premised to result in positive, proactive results. Surveys carried out in relation to the CDM Regulations suggest that while legislation has increased safety awareness and will in time have a beneficial effect, many especially those in small and medium enterprises are sceptical on the cost/benefit results. Overall the application of safety in design is not considered to be of paramount importance compared to other performance criteria e.g. specification, suitability of purpose and completion time. These studies clearly indicate that insufficient time is dedicated to the implementation of safety procedures during the design phase. This paper concludes that there is much need for improvement. Designers need more information about the projects' potential hazards at a time when information is traditionally scarce. The ability to effectively communicate design intentions is critical for safe construction and maintenance operations. Research into the communication of safety during design is therefore crucial for future improvements.

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