A STUDY OF HAZARD PERCEPTION AMONG CONSTRUCTION WORKERS: ADRESSING METHODOLOGYCAL ISSUES OF USING NAVIGABLE MOVIES AND REPERTORY GRIDS

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Abstract

This paper aims to understand how construction site users categorise hazards of their own working environments. The principal focus of this paper is the elicitation of hazards and their relationship to working systems in terms of perceived danger, as they might affect decisions regulating design, management and training considerations. The study was undertaken in laboratory conditions, the participants were presented with simulated scenarios of their everyday working environment using navigable movies. The interviewing mechanism was the repertory grid technique.

Keywords: subjective perception of hazards; navigable movies; repertory grids; qualitative data collection

Accidents in the work place

The interest in safety awareness among construction professionals within the UK has increased in the past five years. Several mechanisms were implemented to deliver a safer working environment for construction employees. These include: The Construction, Design and Management Regulations (Williams 1996), training programs and safety campaigns, all forming part of the Government's agenda to reduce the number of accidents that occur within the industry.

Statistical figures from the Health and Safety Executive (1999) show that in 1994-95, the year prior to CDM, there were 88 fatalities in the industry and 2627 major non-fatal injuries. Four years on, the latest for which statistics are available, fatalities had dropped to 70 - the lowest figure for two decades (see fig.1)- but the number of notified accidents had actually risen to 4169.

The non-fatal-major injury rate for employees is expected to be 399.2 per 100,000, almost as twice that for 1995/96. According to the HSE this is a consequence of *under-reported* accidents prior RIDDOR'95 reporting regulations (1999). Although statistical figures draw a blurred picture of assessing the industry's safety record, if compared to four or five years ago, it is clear that the number of fatalities has decreased, but major-non-fatal accidents has increased (see fig. 2)

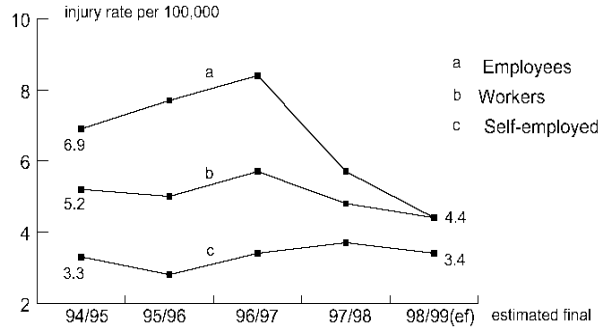

Fig 1. Fatal injury rates in Construction, H&S Executive 1998/1999

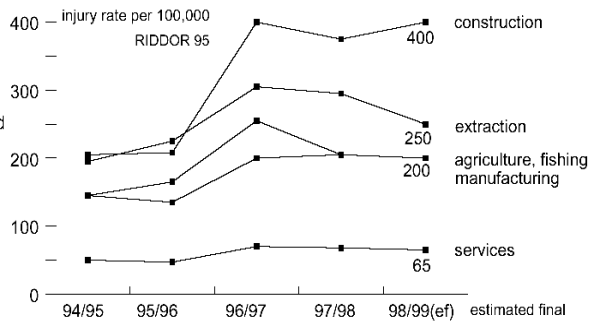

Fig 2. Non-fatal major injury rates to employees by industrial sector, H&S Executive 1998/1999

The statistics seem to suggest that accidents can migrate and reappear within the system in different form and degree, e.g. the latest figures show that there are less fatalities but the number accidents has increased to reach its highest point since 1996, when the CDM regulations where introduced.

An assumption to this phenomenon is that underlying behavioural processes exists, thus when safety systems are introduced might be effective but in the long run, users will *compensate* their risk taking behaviour and accidents will come back in different form and degree. Research in fields away from construction have identified this behavioural phenomenon, some emergent theories include: risk compensation theory (McKenna 1988), risk homeostasis theory (Wilde 1988), zero-risk theory (Summala 1988), subjective expected utility (von Newman 1947), sensation seeking (Eysenk 1983), of which some have been successfully implemented in economics, i.e. insurance companies (Bell 1984) and transport, i.e. reducing car accidents (Parker 1992).

So far, the main systems which attempt to safety in the UK construction industry have not consider the repercussion in the Success or failure of the current safety system in the UK's construction industry might be highly affected by this behavioural reaction to system modifications however it has being ignored in the over all scope, including: design of physical safety systems, management, legislation and safety training.

Human response to hazards

In order to study the risks associated with construction work it is essential to have a valid model of an accident. A number of models have been proposed on how an accident takes place (Rockwell 1967; Lee 1981; Slovic 1981; MacGill 1986); the model on fig. 3 firstly was developed by the Australian Child Accident Prevention Foundation and has been adapted by the Home Accident Surveillance System (Pearce 1986). This particular model brings a clear and comprehensive picture of how accidents occur thus the reason to adopt it.

A typical accident in the built environment is a process, not a single isolated event (Pearce 1986), and this brings us to look at 'the accidents event' from a much broader social scope i.e. the victim's number of children. Applying the model, one could start analysing the stable background features of the individual:

- The person: refers to personality, intelligence, expertise, social background, age, sex, income and resources, family structure.
- Social environment: neighbourhood, work atmosphere,
- Natural environment: topography, time of the day, weather.
- Product environment: these are features of the product itself (i.e. a house, a tool), its design, its age, type and condition.

Usually an activity relates the person to the product: an operative is using a power tool or some piece of equipment, and the activity is associated with temporary influencing factors which may be human stress, fatigue or the environment in which this person is working in. Poor design features of the product may lead to a propensity to an accident.

Human and environmental modifiers are mechanism that exist to avoid accidents, they are positioned in the area of secondary prevention, these focus on minimising injuries when the accident does take place, for example wearing the hard-hat or other protective equipment and try to make sure that people are hurt as little as possible if an accident takes place. Human modifiers deal with areas of supervision, development of knowledge skills, training systems whereas environmental modifiers look at legislation of behaviours, product safety codes, product instructions, safety devices, and social policy.

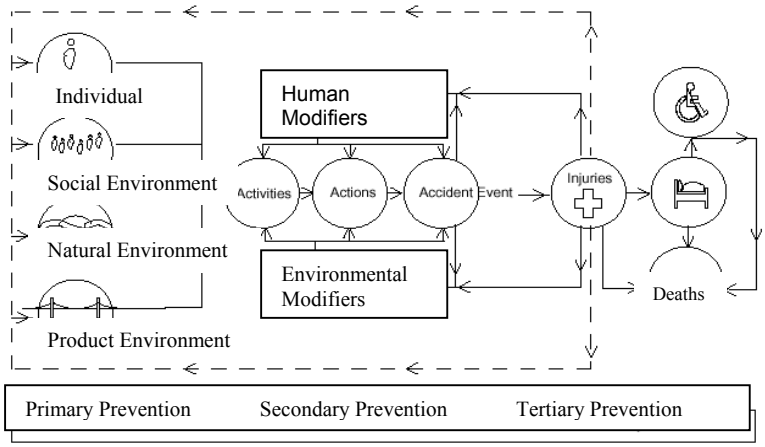

Fig 3. The Accident/ Injury Process Model, modified from the: Australian Child Accident Prevention Foundation.

The Technique

Repertory grid technique is closely related to the personal construct psychology developed by George Kelly (Kelly 1959), it views people as enquirers and inventors of their worlds. Although it is comprehensive, it does not seek to completely define the psychological world but enables a discourse in the process; that is, the typical ways they make representations of the social/emotional environments and the assumption is that these internal representations largely determine people's representations.

These representations are established by a procedure known as 'dyadic and triadic elicitation'. The participants were exposed to three virtual scenarios of their own workplace, and asked which two are alike and unlike the third. They were also asked for the reasons for similarity and dissimilarity. The reason given for two places being similar and different from a third becomes a bipolar construct (e.g. a safe workplace- a dangerous workplace). The process is then repeated with a further group of places and a second bipolar construct is elicited. Further groups of three different places at work are presented until the subject's repertory of constructs distinguishing the object is exhausted.

User behaviour will partially be a function of the cognitive schemata by which participants represent features, functions and operations of their environment (Kelly 1959; Maher 1969; Mair 1988). By using the repertory grid technique this investigation aims to explore the following two questions: (1) how site operatives and construction workers view hazards at work (2) How could those representations vary when the system/situation has been modified.

An interactive multimedia tool was designed to simulate the place under scrutiny on a distance basis, in this way triads with participants were carried in a room context avoiding site disruption and reducing travel costs, but more, important it was possible to expose participants to the same environmental conditions including: place and event.

Video simulated environments have been widely used in psychological research as powerful tool to control situational variables (Horswill 1994). The interactive tool designed for this study is based on the use of *navigable movies* also known as still-video. In the context of the built environment, navigable movies fulfil the need of visualising existing environments, they are based on photographic images an as such they provide a reliable source of information avoiding the linearity and passiveness of traditional video.

Identified advantages of the use of navigable movies over other visual media:

- They indicate desired as well as undesired aspects of a building site, situations of interest can easily be reproduced; this is because they are based on photographic techniques.
- They simulate a distant location introduced in a room context.
- They allow exploratory interface, capturing situations on time and users can explore scenarios.
- Egocentric interface, this means that scenarios are explored at the users will.
- They show 'what is there' but not how or since when, this is because they are not showing physical actions.
- As with digital photographs, elements in navigable movies could be introduce/remove

Procedure

Description of the place of study:
New headquarters office development of 38,000 sq ft in the Thames Valley, UK.
Building stage: structure erecting, cladding, roofing and building services installations

Contractor: Wates Construction

Priming participants: 15 construction workers with a minimum of two years of work experience where invited to participate in the study, they were called -by the site manager- and asked if they could spare an hour to interact with multimedia videos and to discuss safety at work -the study was carried on an individual basis.

Participants included: electricians (2), carpenters (2), plumbers (2), bricklayer (2), scaffolders (2), steel erectors (2), concreters (2), forklift operative (1). Characteristics: all where British, all where male, non of them had suffered any serious accident. The most experienced participant was a scaffolder with 23 years within the trade; the least experience was a bricklayer with two years within the trade.

Procedure:
Firstly participants had to explore the various places of investigation on a simulated walkthorugh, a bird-eye navigation map indicated the various points to be explored.

On a second stage, randomly sorted groups of movies -done by the repertory grid program- where shown to the participant, the scenarios were chosen so as to cover a wide variety of site characteristics. Participants where presented with sets of three site locations at the time. Then, they were asked to name a similar aspect of two locations and a different one from the third location in terms of safety at work- in other words, what made the two they selected similar and what made them different from the third. Details of the responses are listed as the two poles in the bipolar constructs. This process was be repeated with various combinations until all the existent scenarios where clearly differentiated.

Element rating: A third stage is when all elements where rated from 1 to 7 using the constructs as reference points, in this case if we had five places as elements and five bipolar constructs a matrix table of five by five with ratings was formed by each participant. Grids can be analysed individually or compared with other grids to define links and similarities between individuals and groups. The interviews were also recorded as a means of grids back up.

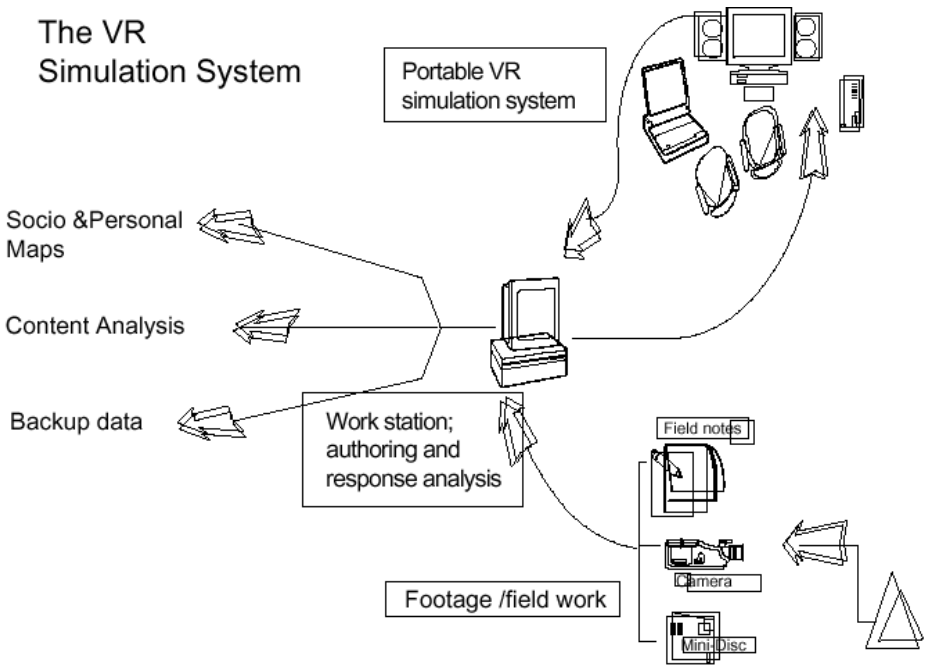

Fig 4. The simulation system: image capture, authoring, delivery and processing mechanisms.

Five movies were embedded to the repertory-grid program originally developed by Gaines Shaw (Gaines 1980; Shaw 1990). The resulting system is a desktop interactive tool that enables the participant to explore the scenarios in a random way and elicit constructs. The procedure of sorting the movies through the program eliminates the inconvenience of having to arrange the movies in a manual way. The method has shown to be non-threatening to the participants since navigation does not require computational skills- and enables a more convenient way to capture responses for the facilitator.

Results

The analysis of various working scenarios was used to elicit constructs from construction workers with the aim to have a better understanding of how they perceive and classify hazards at their work place; in this way it was possible to examine their beliefs and attitudes.

Analysing the repertory-grids it was identified that participants created two groups of constructs: physical constructs and emotional constructs. Physical constructs were those related to the place, e.g. need to wear protective gear, bad weather conditions, need for demarcation systems, noise pollution. Emotional constructs were related to situational events including: stress, work climate and incentives, management style, level of expertise.
The responses have been grouped into the following three main groups:

- The place: physical attributes of the work-place
- The people: stress and incentives
- The organisation: safety communication.

I t was found that some safety procedures – including some training programs - aim at narrow targeted areas-, it is believed that accident reduction requires a long term commitment.

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