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Causal factors in construction accidents

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Causal factors in construction accidents

Prepared by **Loughborough University** and **UMIST**
for the Health and Safety Executive 2003

RESEARCH REPORT 156

HSE
Health & Safety Executive

Causal factors in construction accidents

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This research used a combination of focus groups and detailed study of 100 construction accidents, using an ergonomics systems approach, to identify where safety is compromised and why. Drawing together the findings, an accident model has been proposed, illustrating the hierarchy of influences in construction accidents. The model describes how accidents arise from a failure in the interaction between the work team, workplace, equipment and materials. These immediate accident circumstances are affected by shaping factors, whereby the actions, behaviour, capabilities and communication of the work team are affected by their attitudes, motivations, knowledge, skills, supervision, health and fatigue. The workplace is affected by site constraints, work scheduling and housekeeping. The suitability, usability, condition and, therefore, safety of materials and equipment depend on their design, specification and supply/availability. These shaping factors are subject to originating influences, including the permanent works design, project management, construction processes, safety culture, risk management, client requirements, economic climate and education provision. Achieving a sustained improvement in safety in the industry will require concerted efforts directed at all levels in the influence hierarchy.

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EXECUTIVE SUMMARY

Although the British construction industry is one of the safest in Europe, one third of all work fatalities happen in construction and construction workers are six times more likely to be killed at work than employees in other sectors. A similar situation exists for non-fatal accidents. Although previous research has led to a good understanding of the extent and pattern of accidents in the construction industry, there has been only limited objective analysis of the full range of contributory managerial, site and individual factors. With this background, the study had the following aims:

1. To collect rich, detailed data on the full range of factors involved in a large sample of construction accidents.

2. Using this information, to describe the processes of accident causation, including the contribution of management, project, site and individual factors in construction industry accidents.

The research used a combination of focus groups and studies of individual accidents in pursuit of these.

FOCUS GROUPS

Seven focus groups were held with industry stakeholders to identify issues for subsequent investigation in the accident studies. The groups comprised 5-7 participants as follows: (1) client team, (2) senior managers, (3) site managers, (4) operatives – large site, (5) operatives – small site, (6) construction safety professionals, (7) mixed group. Participants were recruited on a convenience basis, via the industrial collaborators on the research steering group. Each group was asked to consider where failure occurs and why accidents still happen, with the ensuing discussion structured under the headings of project concept, design and procurement; work organisation and management; task factors; and individual factors.

The focus groups led to wide discussion, with strong opinions expressed regarding the sources of problems with safety and the causes of accidents. The main themes to emerge were suggestions that:

- Clients and designers give insufficient consideration to health and safety, despite their obligations under the CDM regulations.
- Price competition among contractors gives advantage to companies less diligent with health and safety.
- Key documentation, such as the health and safety plan, method statements and risk assessments are treated as a paper exercise, having little practical benefit.
- Lengthy sub-contractor chains result in elements of the construction team being distanced from responsibility, inadequately supervised, and with low commitment to projects.
- Frequent revision of work schedules leads to problems with project management and undesirable time pressure.
- A long hours culture in the industry results in fatigue, compromised decision-making, productivity and safety.
- Bonus payments act as a strong incentive, but encourage productivity over safety.
- A skills shortage in the industry is leading to increased reliance on inexperience workers, coupled with difficulties verifying competency.
- Problems exist with the availability, performance and comfort of PPE.
- Training is seen as a solution to all problems, but with content often superficial.

- There have been improvements in safety culture over recent years, but safety still has to compete with other priorities.

ACCIDENT STUDIES

One hundred accidents were then studied in detail, to collect further evidence on the issues raised by the focus groups. Access to accidents was obtained through organisations that had previously agreed to participate in the research, via companies contacting the project team in response to project publicity, and through approaches to industry contacts already known to the researchers. Sampling was on a quota basis, to ensure a spread of accidents across construction build type and RIDDOR accident categories. Criteria for inclusion in the study were that the accident was not subject to investigation by HSE, that the accident had occurred within the preceding two months, and that the accident victim and supervisor/manager were still on site and willing to participate in the research.

Site based data collection entailed interviews with accident involved personnel and their supervisor or manager, inspection of the accident site (where this still existed), and review of relevant documentation, such as accident notification form, risk assessment and method statement. A report of the site based findings was then prepared and reviewed by an expert pairing of a construction and ergonomics (human factors) specialist from within the research team. The expert pairing suggested areas for further follow-up examination. Where possible, issues identified by the expert pairing were pursued directly with the designers, manufacturers, and suppliers relevant to the incident. In many of the studies, however, this proved impossible due to difficulty identifying the appropriate individuals to contact and then securing their cooperation in assisting with the research. In these cases, the issues were instead discussed with other professionals, independent of the accident, but qualified to comment.

Due to the need to avoid incidents subject to HSE investigation, most of the accidents studied were not reportable under RIDDOR. However, following assessment of the possible outcomes of each accident, more than a third were judged to have had the potential to have caused a fatality and more than two thirds could have been 'major' as classified under RIDDOR. On this basis, it is argued that it is reasonable to generalise the findings concerning causation from this sample to more serious accidents.

The research has found that:

- Problems arising from workers or the work team, especially worker actions or behaviour and worker capabilities, were judged to have contributed to over two thirds (70%) of the accidents. This points to inadequate supervision, education and training.

- Poor communication within work teams contributed to some accidents, due to the physical distance between work colleagues or high levels of background noise.

- In many cases, the accident occurred when those involved were not actually performing a construction task, but moving around site, for example.

- Workplace factors, most notably poor housekeeping and problems with the site layout and space availability, were considered to have contributed in half (49%) of the accident studies. Standards of housekeeping and workplace layout with respect to safety are low in construction when compared with other industrial sectors.

- Despite poor weather often being cited as one of the reasons for construction having a poor safety record, this research found little evidence in support of this.

- Shortcomings with equipment, including PPE, were identified in over half (56%) of the incidents. Poor equipment design and inappropriate use of equipment for the task were prominent aspects of this. Designers, suppliers and purchasers of equipment appear to give insufficient attention to the safety of users.

- Deficiencies with the suitability and condition of materials, including packaging, featured in more than a quarter (27%) of incidents. The operation of the supply/purchase chain at present appears to act as a barrier to innovation as far as safety is concerned.

- Originating influences, especially inadequacies with risk management, were considered to have been present in almost all (94%) of the accidents.

- Frequently, no risk assessment had been undertaken covering the circumstances involved in the accident. Where a risk assessment had been carried out, it was often found to be superficial and unlikely to have prevented the accident.

- It appears that PPE is relied upon habitually as a substitute for risk elimination or reduction at source.

- It was judged that up to half of the 100 accidents could have been mitigated through a design change and it was found that, despite CDM, many designers are still failing to address the safety implications of their designs and specifications.

- Accident investigation by employers or supervising contractors is frequently superficial and of little value as far as improving safety is concerned. It appears that HSE investigations generally focus on safety failures in the activity being undertaken, without capturing the upstream influences upon these.

- The influence from clients on safety appeared limited in the construction sectors predominant in this research (civil engineering, major building, residential). This was, again, despite the responsibilities on clients imposed by CDM.

- Many of the incidents were caused by commonplace hazards and activities that will continue to occur on site whatever design changes might be made. The widespread presence of the many generic safety risks accompanying construction needs to be tackled before the benefits of design improvements will be realised.

Together, these factors point to failings in education, training and safety culture in the industry. A large majority of those working in construction, both on and off site, continue to have only a superficial appreciation of health and safety considerations.

Drawing together the findings from the research, an accident model has been proposed, illustrating the hierarchy of influences in construction accidents. The model describes how accidents arise from a failure in the interaction between the work team, workplace, equipment and materials. These immediate accident circumstances are affected by shaping factors, whereby the actions, behaviour, capabilities and communication of the work team are affected by their attitudes, motivations, knowledge, skills, supervision, health and fatigue. The workplace is affected by site constraints, work scheduling and housekeeping. The suitability, usability, condition and, therefore, safety of materials and equipment depend on their design,

specification and supply/availability. These shaping factors are subject to originating influences, including the permanent works design, project management, construction processes, safety culture, risk management, client requirements, economic climate and education provision.

RECOMMENDATIONS

Achieving a significant and sustained reduction in accidents will require concerted efforts directed at all levels of the hierarchy of causation. Important points are:

- Responsibility for safety needs to be owned and integrated across the project team, from designers and engineers through to skilled trade personnel and operatives.

- Other research has shown how the lead given by front line supervisors has a strong influence on safety performance. Worker participation in managing safety is important, to generate ideas and to build ownership and responsibility.

- Where safety depends on communication and coordination, it is important that a robust safe system of work is established.

- A step change is required with standards of site layout and housekeeping. principal contractors should raise expectations of what constitutes acceptable practice.

- Greater attention should be given to the design and selection of tools, equipment and materials. Safety, rather than price, should be the paramount consideration.

- There needs to be greater sophistication with the design and use of PPE. Current PPE is often uncomfortable and impedes performance. Forcing workers to wear PPE when risks are not present is counterproductive. PPE should be a last rather than first resort for risk management.

- There is a need across the industry for proper engagement with risk assessment and risk management. Emphasis should be on actively assessing and controlling risk, rather than treating risk assessment as merely a paper exercise.

- Construction should be encouraged to benchmark its safety practices against other industries. The excuse that construction is ‘different’ in some way does not stand up to scrutiny.

- Greater opportunity should be taken to learn from failures, with implementation of accident investigation procedures, both by employers and HSE, structured to reveal contributing factors earlier in the causal chain.

- It is important that ‘safety’ is disassociated from ‘bureaucracy’.

- Frequently, safety does not have to come at a price. Where there are cost implications, however, regulatory bodies and trade associations should work to make sure there is a level playing field.

Most of these changes depend on achieving widespread improvement in understanding of health and safety. Education is needed over training, so as to promote intelligent knowledge rather than unthinking rule-based attention to safety.

1 INTRODUCTION

The research presented in this report arose from a submission to the 1998 HSE Competition for Ideas. The study proposal was prompted by recognition that safety in the construction industry continues to be a serious problem, with construction having more accidents of greater severity than other industrial sectors. Since then, the spotlight has turned on the industry in the UK, with high profile initiatives such as Rethinking Construction (DETR, 1998) and Accelerating Change (Strategic Forum for Construction, 2002) concerned with the wider performance of the construction industry, including its poor health and safety record. This study and complimentary work by BOMEL (2001 and work in progress) is contributing to the HSE *Revitalising Health and Safety in Construction* review of strategy for the sector.

The industry has generated this attention because, despite considerable efforts directed at reducing the number of deaths, injuries and ill health, construction has one of the highest rates of fatal and major injuries. When the number of fatal injuries are compared in all industries (1998/99 -2000/01) the construction industry accounted for 33% of all work related deaths.

The 2000/2001 statistics (HSC, 2001a) made disturbing reading:

- Overall, the number of fatal injuries reported for construction was 31% higher than the previous year and the highest for ten years.
- A breakdown of fatal accidents in 2000/01 showed the majority resulted from falls from height (44%); being struck by a moving vehicle (17%); being trapped by something collapsing or overturning (17%); and being struck by a moving/falling object.
- There was a similar pattern of reported non-fatal major injuries to workers.
- Although the rate of over 3-day injuries in 2000/01 was the lowest for ten years, the most common causes of injuries were handling, lifting or carrying (34%); slips, trips or falls on the level (19%); being struck by a moving/falling object (18%); and falls from height (14%).

These accident causes have characterised the industry for decades suggesting that lessons from the past have still to be learnt. Although figures for fatalities are accurate, surveys commissioned by HSE indicate a reporting rate by employers for other reportable injuries of less than 40% (Drever, 1995). Thus, the published statistics are the tip of the iceberg. Accidents in the construction industry represent a substantial cost to employers and society.

The most recent health and safety statistics for 2001/02 (HSC, 2002) do give hopeful signs that progress is being made, with a decrease in fatalities and reported major injuries. However, the analysis points out that it is unclear to what extent the decrease in injuries is real or due to underlying variation in reporting rates.

At the time this project was instigated, previous research on accidents and injuries in the industry had largely been confined to the collection, analysis and interpretation of data derived from accident reporting schemes, such as RIDDOR (eg Culver et al, 1993; Hinze and Russell, 1995; Hunting et al, 1994; Kisner and Fosbroke, 1994; and Snashall, 1990). This approach is limited by problems with data collection (eg under reporting) and the broad classifications used for coding. Problems of this nature were reported by BOMEL (2001) in their more recent analysis of RIDDOR data. Previous work by ourselves had found the quality of accident data collected by construction companies to be poor, coupled with a failure to collate and undertake effective analysis of the data that are collected (Gyi, Gibb & Haslam, 1999).

HSE (1978, 1988) used case study procedures to examine fatal accidents and identified causes such as failure to ensure safe systems of work, poor maintenance, use of defective materials, and poor supervision and training. However, the reports concentrated on fatal accidents and it is probable there are differences in the aetiology of non-fatal accidents (Saloniemi and Oksanen, 1998). Whittington et al (1992), in a project funded by HSE, is one of the few other studies that has attempted to undertake systematic analysis of accidents in the industry. Their findings identified a range of headquarter, site and individual factors in accidents examined, approximately in the ratio 1:2:1. Whittington et al acknowledged limitations of their work due to the relatively small number of accidents investigated (30) and incomplete information in the accident records. In addition, there had been important changes affecting safety management since Whittington et al's research, particularly in connection with the introduction of the CDM regulations (HSC, 2001b).

In a UMIST study, examining behaviour modification approaches to improving construction safety, Duff et al (1994) developed a safety audit checklist, used to monitor safety performance of construction sites. Further work by Suraji & Duff (2001) at UMIST led to a model of risk factors for accidents in construction operations. The UMIST model distinguishes between problems with operator actions, site conditions and construction practices, and linkage of these with project, contractor and process management influences. The model is theoretical and the intention was that this research would contribute to its evaluation. In recognising that project concept, design and management factors are frequently an origin of site based failures, Suraji & Duff's approach is a significant development on other theoretical 'root cause' models that confine their attention to site personnel, their behaviour and actions (Gibb et al, 2001; Suraji and Duff, 2001).

In summary, while there is good understanding of the extent and pattern of accidents in the construction industry, there has only been limited objective investigation regarding the full range of contributory managerial, site and individual factors. This study addressed this problem, having the following aims:

1. To collect rich, detailed, data on the full range of factors involved in a large sample of construction accidents.

2. Using this information, to describe the processes of accident causation, including the contribution of management, project, site and individual factors in construction industry accidents.

Pursuit of these objectives was achieved using a combination of focus groups and accident studies, Figure 1. The focus groups were held at the commencement of the research with stakeholder representatives from the industry having an influence on or concerned with safety. The accident studies involved in-depth investigation of 100 accidents, as soon as possible after each incident had occurred. Examination of off-site influences on the accidents was achieved through accident-specific (investigation of paths of causality in individual accidents) and accident-independent (expert opinion on generic issues) methods.

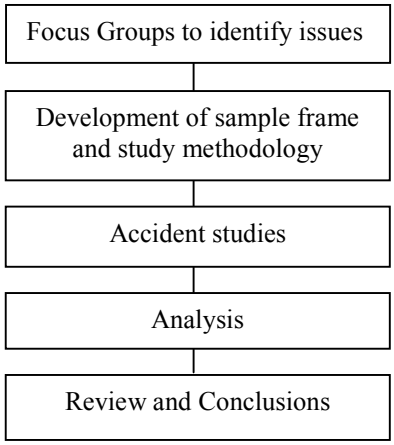


Figure 1 Summary of research methodology

2 FOCUS GROUPS

The aim of the focus groups was to consult stakeholders in the construction industry, exploring where failure occurs and why accidents still happen.

A focus group is a style of group interview whereby the data obtained arises from the interaction and discussion generated from within the group (Morgan and Krueger, 1998). Groups are guided by a moderator, with a style that can be more or less directive, depending on the nature and purpose of the investigation.

A degree of caution is required interpreting focus group findings. For example, groups may generate a level of conformity and acquiescence, suppressing individual views that might be held in private. Alternatively, the researcher may direct discussion into an area unimportant to participants, or achieve this through data interpretation. Nonetheless, focus groups are an established method for gaining insight into views surrounding a research question.

2.1 METHOD

2.1.1 Participants

Seven groups were conducted (Table 1) with an earlier pilot group run with construction undergraduates. Assistance in accessing appropriate focus group members was provided by collaborators from the research steering group.

Table 1 Focus group categories and participants

Group	*Employment*	*Target participants*
One	Client team	Planning Supervisors and health and safety specialists
Two	Senior managers	From general and specialist contractor firms representing civil engineering, major building or residential sectors
Three	Site Managers	Mix of those in general supervisory and managerial roles and those with health and safety responsibilities
Four	Operatives (large site)	Tradesmen or general operatives
Five	Operatives (small site)	
Six	Safety professionals	Industrial safety professionals and construction enforcement officers
Seven	Mixed group	A mixed discipline group (trades and professionals)

The composition of group one varied from original intentions, due to the practicalities of recruiting participants. It had been hoped that group one would include individuals representing client, architect, design, engineer roles. The absence of contributions from these backgrounds is reflected in the results. All groups had between 5-7 participants.

The seven groups took place between February and June 2000. The 'safety professional' group was held at Loughborough University campus, whereas all others were based at a location convenient for the participants.

2.1.2 Information for participants

A review of the work of Whittington et al (1992), HSE (1997 and 1999) and Suraji & Duff (2001) generated four discussion areas for the focus groups:

1. Project concept, design and procurement
2. Work organisation and management
3. Task factors
4. Individual factors

Participants were provided with a briefing sheet describing the nature of focus groups and summary details of the research. At the outset of each focus group, overhead transparencies were used to provide a short presentation of the research and focus group discussion areas (not reproduced here). Participants were assured of anonymity.

To clarify and distinguish the four discussion headings, examples were provided to enhance the participants' understanding and to prompt discussion. These examples were developed with the assistance of a construction specialist. Each of the four discussion areas (and examples in brackets) was presented on a flip chart sheet (Table 2-Table 5).

With each theme participants were asked to consider where failure occurs and why accidents still happen.

Table 2 Project Concept, Design and Procurement

• Client background (skills and experience of the client)
• Selection of design team (Designers giving consideration to practicalities of construction?)
• Procurement of contractors (What role do price and safety play in selection?)
• Safety considerations (Safety in construction considered?)
• Allocation of resources (Financial – where the money is spent)
• Legislation (Enhances or hinders?)
• Strategic design considerations (Choices of site, appropriate building design)

Table 3 Work Organisation and Management

• Project management and supervision (Style, degree of input and instruction from management and supervisors)
• Managing change (Handling of any design modifications of work in progress)
• Work scheduling (Time pressures, overlap of operative / trades)
• Resources (Availability of contractors, suitable skills of contractors)
• Safety considerations (Risk of injury assessed, safety managed appropriately)
• Site layout and logistics (Safe access routes, placement of essential services)

Table 4 Task Factors

- Tools and equipment (Appropriate selection, maintenance)
- Adequacy and use of procedures/method statements (Appropriate?)
- Is safety considered?
- Training in task and health and safety skills (Appropriate?)
- Work load / time constraints (Time pressure upon individuals and/or groups)
- Environmental conditions (Weather, out of hours work)
- Design of task or working area (Layout of immediate area, is safety and access considered?)

Table 5 Individual Factors

- Experience and competence of all employees
- Safety considerations (Safety behaviour, attitude to risk)
- Personality influences
- Health status and fitness for work
- Conformity (Company ethos, pressure to comply)

2.1.3 Procedure

Each group was scheduled to last 1½ hours, but with the time allocation used flexibly. Audio recordings were made of each focus group to permit subsequent transcription.

2.1.4 Analysis

An abridged transcription was made from each audiotape. The transcriptions recorded the main points made as each participant spoke. This included a number of quotes where these were clear and salient points.

To facilitate interpretation of the transcriptions, intermediate analyses were undertaken which involved summarisation of all text into short bullet point statements. These were a subjective interpretation by the researcher of the main points of what the speaker was saying. This enabled significant points to be extracted and permitted later comparison and categorisation of information according to the discussion area headings and sub-headings.

The analysis aimed to identify:

- the nature and range of the discussion data
- differences between opinions of each group or among participants
- whether any of the prompts were omitted from conversation by participants
- if additional and unexpected aspects were introduced into the discussion

2.2 FOCUS GROUP RESULTS

The focus groups provided a valuable insight into the perceptions of stakeholders across the industry regarding safety and accident causation.

It is important that readers are aware that in reproducing the essence of the focus group conversations, no judgement is made on whether the views expressed are right or wrong. It is also possible that in some respects, focus group participants may be factually incorrect or hold opinions with which others disagree.

The main views are expressed as bulleted comments (in no particular order) under the four main discussion headings.

2.2.1 Project Concept, Design and Procurement

Client background

- It was perceived that the larger high-tech organisations such as the petro-chemical and oil industries had a responsible attitude towards construction safety and anticipate costing for this at the project concept stage.
- Clients were considered to vary in their commitment to health and safety. Many criticisms were directed at client ignorance in certain areas of the process, such as their legislative responsibilities under CDM, the contractor's responsibilities and the practical implications of any build or design changes they request.
- The decisions of many clients were portrayed as frequently being determined by the lowest-price tender, avoiding being accountable for a breach of the law and maintaining a high public profile (e.g. environmental issues, or general public safety being a high priority) but not the welfare of construction workers.
- Clients were reported to impose considerable time pressures, to be inflexible and to have a perpetual urge to trim construction times.

Strategic design considerations

- An increased desire for aesthetic qualities was generally seen to inhibit ease of building which in itself induces safety hazards.
- It was felt that time and financial pressures from the client impede appropriate opportunities for review or audit of designs yet, were this possible, it would permit deferral of responsibility back to the client for revision (instead of contractors having to accommodate this late in the process).
- It was understood that designers positively encourage off-site pre-assembly and that there are great benefits in this, especially to compensate for a lack of available skills on-site and to make a faster, more buildable and safer structure. It was however also reported, that pre-assembly often does not account for continuously developing prototypes. Pressure needs to be put on manufacturers to revise products; an example was provided concerning design revision of timber trusses, whereby the manufacturers were reported to have ignored requests for design improvements.
- Clients were heavily criticised for not leading design innovation.
- There was a general rejection of traditional management whereby price and speed of construction directed the process.

Allocation of resources

- It was reported that clients (and mostly their lawyers), make the money in construction, with price being their priority in important decisions such as contractor appointment or apportioning appropriate arrangements for safety.
- Cost incentives mean that longstanding 'fixed' client-contractor relationships are diminishing and that there may be some pressure to attribute 'competence' to those submitting the lowest tender. Although clients are required to consider safety in tenders, this was reportedly not necessarily the case; it was felt that in built safety costing in a tender had led to both loss and acceptance of contracts.

Selection of contractors

- It was reported that the selection process is generally a paper-based exercise and some documentation, used universally, is more than ten years old.

- There were comments that the Health and Safety Plan is generated more to impress the client than to be used as a working tool, and contains meaningless generic statements about hazards.
- General thoughts were that principal contractors are more safety aware than sub-contractors and that sub-contractors often have a poor safety culture and do not adequately price safety in tenders.

Safety considerations

- It was reported that commercial incentives influence the drive to consider health and safety but that such competition may positively influence the development of new initiatives.
- It was reported that a 'top down' culture drives attitudes towards safety, yet clients are not necessarily offering this commitment and were reported to have ignored contractors' safety requests.
- It was indicated that certain client team members, such as quantity surveyors, designers or structural engineers do not have adequate training to appreciate their impact upon site workers.

Client team

- A number of comments were made about designers acting in an 'insular' manner, not communicating appropriately, consulting other disciplines nor forming part of a team with others on a project.
- As part of a 'design team' it was reported that although the designer is responsible for informing a client of their need to appoint a Planning Supervisor, many are in fact ignorant of the Planning Supervisor function.
- Although it was acknowledged that designers can be good at designing out risk, it was reported that although they are starting to understand safety matters, they have little understanding of health-related issues. It was thought that designers do not necessarily associate their design as having a part to play in influencing accident causation.
- From a scheduling perspective designers were seen as frequently unprepared for work commencement and were reported to be often absent from sites.
- Designers had been known to take between two and three weeks to revise a drawing thus delaying the start (or progress) of the construction works.
- There were reports of inadequate site investigation by designers and that their work had to be double-checked at contract outset.
- It was also pointed out that design is not just about the design team and that this is a loosely used term and many people do not actually know that they are designers. For example, contractors often act as designers, but do not necessarily see themselves as such or appreciate their (legislative) responsibilities in this respect.
- There were reports that Planning Supervisors vary in performance and contribution to a project. Clients, contractors, designers and architects were often considered ignorant of 'Planning Supervisor' functions and as such these professionals are under-resourced and under-used. From a negative perspective it was suggested that some Planning Supervisors are appointed only to protect the client and in this capacity they do not enhance the project.

Legislation

- The CDM Regulations were seen by some as poorly understood or incorrectly addressed by clients and designers. Legal requirements were often treated as a paper exercise and to have created an additional role that clients have had to assume from what had traditionally been viewed as contractor responsibilities.

2.2.2 Work Organisation and Management

Project Management and Supervision

- It was felt that method statements, to a certain extent, reflect the variable quality of information provided by the client or designer. Method statement quality was also seen to be vulnerable to deterioration when highly technical information is the subject matter.
- Although method statements may provide a task breakdown they do not necessarily provide adequate procedural information.
- Method statements are reportedly mistaken for risk assessments and were criticised for accommodating rather than addressing risk control.
- It was said that there is often little variation in method statement content and they were portrayed as an 'office' based exercise, prepared by someone at safety/management level. There was believed to rarely be consultation with the operatives doing the work and consequently inadequate appreciation of or understanding of the demands of their work. The process of developing the method statement was portrayed as a ritualistic paperwork exercise resulting in material that does not necessarily reflect practice. In addition, much of the material was reportedly generic and often boring, too long and not of an appropriate language style for the end user and as a consequence of this it was argued that operatives do not necessarily see, read or understand them.
- With regard to planning it was noted that the parameters for work scheduling always change and may in fact be obsolete even within about three weeks of a project start. Changes to work in progress, due to, for example, design modification, transport and delivery problems, or as a result of weather conditions, contribute to planning problems.
- The consequences of planning problems were described as trade overlap (and loss of work sequence), work back-log and the generation of time pressure – all of which were felt to contribute to risk. It was generally indicated that greater attention is now being given to planning, but that client commitment (to a longer work programme for example) is required.

Work scheduling

- Time pressure within work scheduling was mentioned frequently and was described as having effects upon two interacting factors – work performance and the skill base of contractors. To accommodate time pressure in work scheduling it was indicated that unskilled labour and poor subcontractors are sometimes appointed.
- Nearing the end of a contract, it was reported that performance and quality of work can suffer; negative effects such as short cuts resulting from increased work intensity and trade overlap were cited.
- There were concerns from operatives that they were not appropriately consulted concerning the scheduling of trade overlap resulting in loss of work sequence and in the re-doing of work on occasions.

Resources

- A number of criticisms were made regarding the move from direct labour towards lengthy chains of sub-contractors. The advantages of direct labour (over sub-contractor labour) were perceived as project dedication, better teamwork, a better safety attitude and better overall housekeeping. It was noted that the appointment of sub-contractors is generally 'price'-led and thus competitors undercut each other; this creates pressure to drop standards to be competitive, or to appoint less qualified people.
- Sub-contractors, and especially those most distal in the chain from principal contractors, were seen as distanced from responsibility and ignorant of and not committed to the team work of the site. Secondly the logistical problems experienced by site managers were also noted, especially in co-ordinating and overseeing lengthy chains of sub-contractors.

- Skill availability was reported as a considerable problem for the industry. This affects recruitment and retention of competent sub-contractors, site managers, foremen, and trades-people – a problem noted to be worse in London.
- The consequences of these skill shortages were that people without site specific experience were appointed in trade, supervisory and management positions. At operative level this meant that at times new employees cannot be left unattended and that, in the absence of even the most basic common-sense, considerable pressure is put upon gang leaders to undertake and supervise the work of the operatives.

Safety considerations

- Positive comments were made about the improvement in safety culture in the industry over recent years, and all participants appreciated this. The success of top-down commitment was reported to depend heavily upon the attitude of the project or site manager and of the supervisors or team/gang leaders.
- Inhibitors to effective safety culture were that management on site was generally seen as reactive rather than proactive. Time pressure plays a considerable part in work methods chosen and although it was reported that people may be committed to safety, it was at times portrayed as a competing priority at site level.
- The traditional 'blame-culture' showed signs of receding, but there were still cases where individuals were blamed if procedures were violated.
- Risk assessments were strongly criticised and it was indicated that they can be confused with method statements and are at times of little value. Faults in preparation were described as being inadequate attention to hierarchy of control, inadequate consideration of maintenance issues and, at times, over-specification of risk circumstances (which can inhibit consideration of broader factors). Problems were also attributed to the use of generic risk assessments, which do not include operative consultation and which are of more use as a bargaining tool to impress clients.
- There were also criticisms of the accident reporting system, in that some participants felt that they were prohibitive and that the recording of remedial action could appear very trivial.
- The safety advisor role was generally reported positively and it was felt that support would be given to operatives should they have any safety concerns. It was noted that, to make a stand, a certain amount of self confidence was needed by operatives and that this is how some less experienced / familiar operatives can be influenced to work in an unsafe manner.
- A number of participants indicated that they perceived that the state of housekeeping on a site closely reflects the site safety culture and the attitude of the project/site manager/site agent.

Site layout and transport

- There were a number of comments indicating that the provision of a "lay-out area" has decreased and that this impedes work processes. Access problems to a task area were frequently reported and on occasions, haul roads had to be used to compensate or to accommodate all who need to use a particular area.

2.2.3 Task factors

Tools, equipment and materials

- Although it was generally acknowledged that, where provided by the principal contractor, tools were often good and new to each site, it was indicated, that their selection is too cost motivated and that they were not always freely available.
- Equipment was reported as not always being of a good quality and that there were problems with the selection of the correct capacity tooling and providing adequate maintenance

(directed to lifting equipment). There were some concerns about the unknown quality of equipment that was used by sub-contractors and of the use of multi-functional equipment. One example, relevant to sub-contractor tool-use, was that to compensate for unknown site circumstances, they are known to bring their largest capacity equipment to site, and proceed with using this although the equipment may in fact be too large for the task.

- Availability and use of personal protective equipment (PPE) was reported to vary widely. The impression gained was that for larger companies there were plentiful supplies, but for smaller companies availability was limited and in some cases operatives were expected to provide their own PPE.
- It was acknowledged that non-use of correct PPE does occur and, although this is more likely to happen at the weekend, use was seen as an individual's responsibility. It was indicated that those advocating the use of PPE do not adequately appreciate the practicalities and negative influence on performance from its wear. For example, loss of mobility; helmets that impede vision and fall off unless secured by ear muffs; and goggles that steam up frequently interrupting work in order to clean them.

Task supervision and communication

- Inadequacies were reported with both supervision and communication across the different disciplines at task level, and these were seen as contributing towards accident potential. It was generally indicated that there is more supervision on larger sites. The lack of supervision of lorry drivers and sub-contractors was mentioned a number of times. Particular reference was made to small groups undertaking a high rate of small jobs, who were less likely to be formally managed as their supervisors may cover many different sites. As such, safety behaviour may only be concurrent to the time of the supervisor's visit.
- At site level, the efficiency of supervision was seen to deteriorate with a rise in the volume of sub-contractor labour, yet where supervision was regarded as good, sub-contractors would conform to standard. There were indications, however, that some task requests were inappropriate and that these relate to problems with communication. Within this there were indications that adequate consultation and liaison at trade level was lacking.

Task, techniques and safety factors

- Small jobs, isolated work or short term contracts were seen to involve little forethought and with safety factors more likely to be considered on an ad hoc basis or at an individual level only.
- It was noted that setting up safely and waiting for arrival of, and use of safety equipment can take longer than the job itself. Duration of exposure to a 'risk' was believed to influence an individual's choice of safe working methods.
- More generally, working methods were described by some as outdated, but that there is resistance to, or ignorance of 'new developments'. Additionally improvisation or short-cuts in work methods were seen as contributory to the causes of accidents.

Training in task and health and safety skills

- Induction training was criticised as being overly long and repetitive of base-line information common to all sites (such as PPE) such that workers become blasé about it. It was also reported that they are inconsistently provided and that they do not necessarily deliver the 'appropriate' site-specific information.
- When discussing training in more general terms it was indicated that it is often inappropriately seen as a response to all problems. The provision of training for young people was seen as inadequate (in terms of a lack of appropriate apprenticeships), as was the use of multi-skill training.
- Generally, for training content, it was mentioned that not all understood the terminology used and that Agency staff especially perceived training as a waste of time. It was indicated

that there is a shortage of courses, that training is not provided consistently (no manual handling training for labourers for example) and that larger sites provide more training opportunities.

- The use of a trainer unknown to the trainees appeared to be criticised (and understood in analysis to be due to their lack of understanding/empathy of specific work problems). Additionally the training content was also criticised (especially at task level), whereby it was considered by some that too much time is spent on office-based theory with insufficient time spent on practical field skills.
- The lack of practical field skills was thought especially important. In this respect problems were mentioned with one day training courses that provide a certificate of competence. The certificated person is apparently not evaluated for competence, yet is still expected to display a wide range of skills from a very early stage. It was also reported that working without the correct certification is permitted, but that learning on the job in this manner may convey the wrong techniques.

Work load and time constraints

- The scheduling of workload appeared to be influenced considerably by the revised work patterns and long hours culture that is now prevalent in the industry. Although it was recognised that long hours are well rewarded financially, this is invariably disruptive to domestic life and can routinely entail early morning starts.
- It was also reported that there has been an increase in the introduction of weekend, night and block work by clients. It was suggested that management staff at the weekend may be unfamiliar with workload and that there can be omission of PPE or tolerance of unsafe work practices (especially whilst the Safety Advisor is absent) during this time period.
- Time pressure was repeatedly mentioned in relation to undertaking tasks for example, poor work set-up prior to task commencement, interruptions whilst working, and the pressure to meet deadlines.

Financial considerations

- It was indicated that pay is commonly directly related to the work undertaken and that expectations of payment leads the choice of work methods. Some reported that they no longer see fixed wages for trades people, as all work is now target or bonus related. Financial expectations are high and exceeding the work target and increasing bonus related pay is considered essential for income and the prime incentive for operatives. Bonus pay may be safety-related, but it seemed that most often bonus pay is solely related to task performance.
- It was indicated that there may be a financial penalty if a job is difficult or slow to complete and that any mistakes have to be resolved within the company's or individual's own time. It was also commented that there is a reliance on younger employees and that this is reflected in a low basic wage.

Environmental conditions

- Poor environmental conditions were raised as a factor which can impede work for operatives. It was suggested that, where work has to continue in bad weather, this can induce risk-taking to finish tasks hastily. It was suggested that some operatives, such as pipe layers and scaffolders, may be more vulnerable in wind/rain conditions. It was also reported that bad weather affects morale and especially as some clients can stipulate that there will be no schedule revision in these circumstances.

Job roles at task level

- There was consensus that there are insufficient competent and experienced trades people in the industry and that this has consequences not only in loss of task skills but in safety awareness too.

- Clarity of job role received varied comments and different participants saw this in both a positive and negative light. Firstly, for speed, jobs were reportedly more fragmented nowadays and this could inhibit use of the full range of operative skills. However fragmentation was also seen in a favourable light as certainty and role clarity of just doing specific jobs was valued as well.

2.2.4 Individual factors

Age, attributes and experience

- There appears to be an increased reliance on younger and inexperienced employees on sites and there is particular concern about early responsibility and use of dangerous equipment by younger workers. Although younger workers were described as more likely to follow work instructions, it was perceived that they experienced a high accident rate, especially within their first week of appointment.
- It was also said that construction does not attract high calibre school leavers and at operative level there was a certain amount of concern about the impact of inexperienced people on site, and especially about the lack of even the most basic common sense among newcomers. There were also references to lack of concentration and carelessness.
- The verification of what constitutes 'experience' was reported as difficult to assess. Concerns were people with inadequate skills presenting themselves as a skilled trades person, or the use of trades people from outside the industry being appointed despite reservations of the transferability of their skills onto site.
- Although experienced workers were described as having fewer accidents, experience was also seen to have a negative side. The range of problems associated with experience were noted as work fatigue, over-familiarity and over-confidence, complacency, omission of or low safety awareness, and difficulties in changing work techniques.

Competency issues

- 'Competency' lacked a clear definition for many workers. Moreover, competency needs to be relevant to site conditions/equipment used and can not be inferred just by certification. There was concern among some that too much emphasis is placed upon certification as, for 'managers', this implies competence of workers and defers responsibility from themselves. There was concern too about spurious attribution of competence when convenient (i.e. when a particular task needed doing in a hurry) as it was indicated that proceeding without certification may result in lack of 'cover'.

Attitudes and conformity

- There were a number of reports of pressure to conform, such that jobs must be done at any cost. There was indication too of peer pressure to maintain work pace, especially in the context of achieving the bonus. It was also indicated that a degree of self-confidence and authority was needed to reject pressure to conform, but that once stated it was accepted. On the other hand it was also mentioned that fear of the consequences can inhibit operatives from complaining and as such violations remain insidious and tolerated.

Health status and fitness for work

- One concern highlighted by workers was 'the next day effect' upon individuals of high alcohol intake. This was discussed as being connected with life-style factors associated with the industry, such as site distance from home, long hours and early work starts.
- Other views and differing perspectives of general health status were also noted. For example, that the ability to do a task is evidence enough that a person is adequately fit to do the job. On the other hand, there were also concerns that there are considerable health problems among construction workers, and that operatives are at particular risk and may continue to work with inadequate health status for fear of dismissal.

- Their was a general feeling that ill health and health-related issues (especially slowly developing health issues) are under-appreciated in the industry and that an increase in the extent of litigious action is anticipated in the future.
- The skills shortage was described as leading to the appointment of people with health problems and there were concerns about inadequacies in verification of health status – especially for sub-contractors.

2.3 CONCLUDING REMARKS ON FOCUS GROUPS

It can be seen that the focus groups led to a wide discussion, with strong views expressed regarding the sources of deficiencies in safety and the causes of accidents. Several points were made criticising clients and designers, although it should be noted that the absence of representatives from these stakeholders groups, meant that their voice was not heard. This is likely to have led to an imbalance in this respect.

3 ACCIDENT STUDY METHODOLOGY

This research adopted an ergonomics systems approach, acknowledging the wide involvement of human and physical, proximal and distal factors in construction accidents. The accident studies were 'holistic' and qualitative in nature, concentrating on depth over breadth. The intention was not to apportion blame but to collect evidence on the patterns of causal influences that lead to these complex events.

3.1 SAMPLING STRATEGY

A sampling strategy was devised to ensure that accidents examined for the research would, as far as possible, be a representative cross-section of those that occur in the industry.

3.1.1 UK construction industry profile

Table 6 shows the target sample across four categories of construction build-types, as covered by this study:

- Engineering Construction — Petro-chemical / power generation and heavy industrial
- Civil Engineering — Roads, rail, bridges etc
- Major Building — Non residential building, including refurbishment
- Residential — Houses and apartments

Table 6 Construction profile sampling strategy

	Build type (construction 'sector')			
	Engineering Construction	***Civil Engineering***	***Major Building***	***Residential***
Initial target distribution	5	15	45	35

3.1.2 Representation of UK construction accident types

A second dimension of the sampling strategy was that the studies should cover a broad range of accident causes, as classified under RIDDOR. HSE data for the four-year period 1996/97 – 1999/00 formed the basis of this. Figures were summed for each causal factor for the four-year period, with the percentage representation within each given in Table 7. The sample for this project is included in the table for comparison (Loughborough sample). As described later in this report, a number of the incidents studied (12) directly involved materials, tools and equipment. These incidents do not fit easily into the RIDDOR categories and have therefore been separated out for the purposes of this comparison. These accidents have been included in the results and discussion sections later in this report, however.

In developing the sampling strategy, the research had to operate within the constraint that it was necessary to avoid inclusion of accidents subject to HSE investigation. A policy change within HSE just prior to commencement of data collection led to a requirement upon HSE Enforcement Officers to undertake a much higher volume of investigation of reportable accidents. The result of this was that most major accidents and some 'over 3-day' accidents were no longer available to the research. Because of this restriction on the study design affecting severity of outcome of the 100 accidents, the 'falls' categories have been combined in Table 7. Four of the accidents

studied were categorised as dangerous occurrences (see Table 11), however, here these have been re-categorised under the most relevant heading in the table.

Table 7 Reportable injuries to construction industry workers (1996/7-1999/00) compared with Loughborough University (LU) sample

	RIDDOR fatalities %	*RIDDOR major injuries %*	*RIDDOR over 3day injuries %*	*LU sample (N=88) %*
Falls from a height	55	38	14	{ 24
Slips, trips and falls on same level	0	19	17	
Injured while handling, lifting or carrying	<1	8	34	19
Struck by moving (+ flying / falling) object	15	19	19	22
Struck by moving vehicle	9	3	2	2
Contact with electricity or electrical discharge	8	2	1	2
Trapped by something collapsing or overturning	5	1	<1	7
Strike against something fixed or stationary	<1	3	5	9
Contact with/by moving machinery	3	3	3	5
Other accident events types	4	4	5	10

Table 7 demonstrates that the Loughborough sample provided a reasonable spread across accident categories.

3.2 ACCIDENT STUDIES

Figure 2 summarises the method used for the accident studies. The qualifying period for inclusion in the research was that the accident had occurred within the past two months. This timing was a compromise between the desire to interview those involved in the accidents as soon as possible after the incident, while events would still be clear in their mind, and what proved practicable in terms of gaining access to accidents to study.

3.2.1 Selecting accidents

Figure 3 shows the process adopted for selecting appropriate accidents for the research. Where an accident was reportable under RIDDOR, a representative of the HSE project management team reviewed the possibility of Enforcement Officer action, before giving permission to proceed with the process of site liaison and visit organisation.

The accident notification form is reproduced as Proforma 1 in Appendix A.

3.2.2 Site liaison and visit organisation

Each of the contributing companies provided a list of contacts (most commonly the Area Safety Advisors), with whom a first stage liaison was made to obtain the full details of the accident (for sampling strategy purposes) and site contact information. Arrangements for the site visit were made either via this contact person or directly with site personnel. Discussion with the site contact included a description of the research, what the visit would entail and assurance that all findings would be reported anonymously. In turn the discussion also ensured that the necessary research criteria existed, namely that:

- HSE were not investigating the accident
- The accident had occurred within the preceding two months

- The accident victim and supervisor/manager were still on site and willing to participate in the research

It was also important to emphasize that the work was independent from HSE accident investigations and that all interviews would be undertaken in confidence. Where possible, a briefing sheet was sent in advance of the visit (for circulation to those who would be involved), describing the research and highlighting the voluntary and confidential nature of information provided at interview.

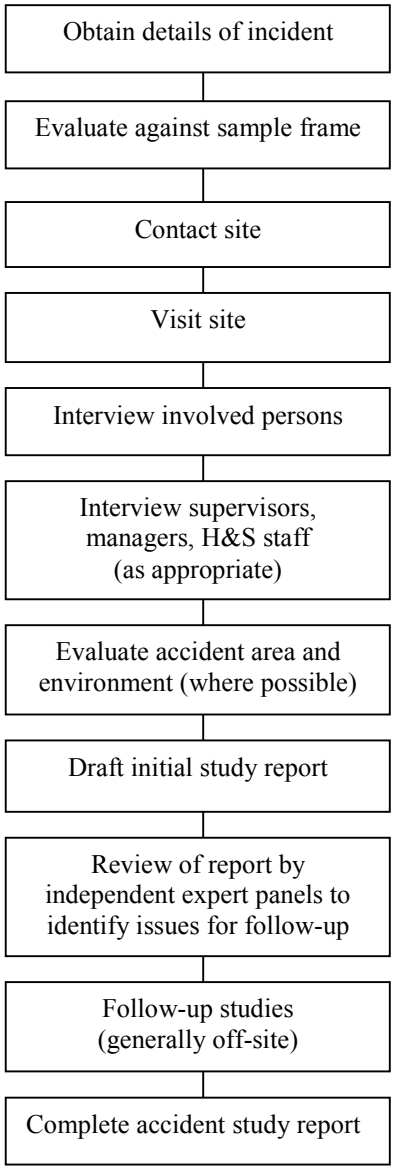


Figure 2 Summary of accident study procedure

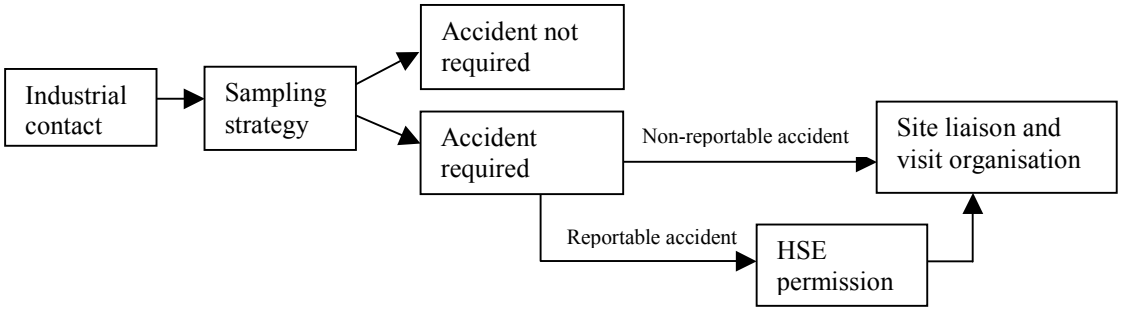


Figure 3 Accident selection process

3.2.3 Site based data collection

The process for undertaking an accident study during a site visit is shown in Table 8.

Table 8 Practicalities of an accident study

On site assessment method			*Additional activities*
1. Upon arrival review accident details with site contact person	Obtain / confirm baseline data including: • accident event information • contact details of personnel involved	Proforma 1	Review and record accident details from the company records
2. Then review accident details with accident involved personnel	Obtain consent and interview relevant personnel, covering aspects such as: • accident event information • work profile aspects • personal details	Proforma 2 Proforma 3	Undertake task based ergonomics assessment (observation, weight / linear measurements as appropriate etc.)
3. Finally review accident details with supervisor / manager / safety advisor	Obtain consent and interview relevant personnel, covering aspects such as: • accident event information • work profile aspects • personal details	Proforma 3 Proforma 4	Evaluate risk assessment and method statements (removing copies off-site if possible)

The main objectives with the site-based interviews were:

- That the methods should be readily transferable across a range of accident and site situations.
  - Different site management structures, build types and stages of build indicated that a broad range of information would be obtained. This meant that the methods should be suitably open and adaptable to incorporate this.

- The methods should be appropriate to the role and responsibilities of the interviewee.
  - It was anticipated that job roles and responsibilities of interviewees would vary between accidents and sites. Beyond the fixed data information requirements, the methods then

needed to gain information about the accident and to acquire information from the perspective of the interviewee in relation to their work circumstances.

- The enquiries should be non-confrontational and encourage the interviewee to discuss issues openly and without inhibition.
  - It was anticipated that there might be some resistance to participation, given fears of blame. The semi-structured interview content and style was developed so that issues readily identifiable and of greater familiarity to the interviewees were discussed first.

- It should be possible to complete the semi-structured interview within a 30-minute period.
  - It was felt that this would provide sufficient time for a full discussion, but would not be unduly demanding or remove the interviewee from their work for too long.

Further proforma were developed as data collection tools for the accident studies, reproduced in full in Appendix A. Each was used as a basis for the confidential semi-structured interviews. Proforma 2 and 4 were for data collection about the work situation, with the main elements of enquiry summarised in Table 9.

Proforma 2 collected data from those undertaking the work activity when the accident occurred. These 'accident-involved' interviewees included any injured party or co-worker. Proforma 4 collected data from those with a supervisory, managerial or safety role. Whilst the questions are different from those in Proforma 2 they addressed the same themes, but with questions relevant to job roles (Appendix A).

Further data collection by the researcher on site included analysis of the work and/or accident event area and content analysis of any supporting documentation (such as risk assessment or method statement for the accident task).

3.2.4 Follow-up investigation

Subsequent to the site visit, a report of the site based findings was then prepared and reviewed by an expert pairing of a construction and ergonomics (human factors) specialist from within the research team. The expert pairing suggested areas for further follow-up investigation, depending on the nature of each accident and the apparent failures which had led to the events. Where possible, issues identified by the expert pairing were pursued directly with the designers, project management team, manufacturers and suppliers, as appropriate, linked with each accident. Architects, planning supervisor, temporary works manager, groundwork contractor, and equipment manufacturers are examples of functions followed-up in this way.

In many of the studies, however, this proved impossible due to difficulty identifying the relevant individuals to contact and then securing their cooperation in assisting with the research. In these cases, the issues were instead grouped together and discussed with other professionals, independent of the accidents, but qualified to comment.

3.2.5 Ethical considerations

There were ethical considerations in this research with regard to ensuring the anonymity of participants and that information collected would remain confidential. Data handling procedures were established to address these aspects, with ethical approval for the accident studies obtained from Loughborough University Ethical Advisory Committee, prior to any data collection taking place.

Table 9 Enquiry areas for site based data collection of the work situation

Proforma 2 *Accident-involved interviews*	***Proforma 4*** *Manager/Supervisor/Safety advisor interviews*
Comments on accident cause and remedial action (Both proforma)	
Task details	
Skill, training and experience issues	Opinions on task content and difficulties
Interruptions &/or task overload	
Known risks (eg chemical, electrical)	
Solitary or gang work	
	Managing design revisions
	Management of redesign
	Problem solving issues
PPE	
Provision, care and training	
Usability comments	
Environment	
Site conditions (such as light, noise, wet)	
Compensatory measures	
Workspace interaction	
Space and movement issues	
Housekeeping	
Comments on tools and equipment	
Work scheduling	
Task, work, rest issues	Managing delays and changes
	Availability of skilled workers
Work organisation	
Interaction / overlap with other trades	Assessing competency
Personnel availability	Liaison and communication
Presence of production targets	Planning teamwork
Consultation and communication issues	Dealing with productivity pressures
	Interacting with sub-contractors
	Provision of training
	Health and safety responsibilities
Work pace	
Determinants of work rate	Motivation of employees
	Managing time pressure
Target / payment issues	
Method of payment	Opinions on conflict to safe working
Use of incentives	
Supervision / Management	
Opinion on adequacy of supervision	Retrospective opinion relating to accident
Communication issues	
Welfare	
Break and facility comments	
Procedures / method statements / risk assessments / training	
Knowledge of documentation & content	Preparation of documents
Perception and use of these	Consultation and communication issues
	Dissemination of information
	Review and evaluation of materials
	Training provision
	Nature of induction,
	Provision of task training & tool box talks

4 ACCIDENT STUDY RESULTS

One hundred individual accident studies were undertaken involving a wide range of site, build and accident conditions. Summary details of the accidents included in the research are given in Appendix B. Findings in the following sections are cross-referenced to examples of the accident study(s) from which they were derived. It is important to note that a count of the referenced accident studies does not indicate relative importance of the issue, nor are the references intended to be exhaustive. Rather, they are examples of involvement across this particular accident sample.

This section of the report deals first with the accident sample and accident circumstances. It then presents an analysis of causal factors, before illustrating the key factors under the headings:

- Worker factors
- Site factors
- Materials and equipment factors
- Underlying causes
- Design potential to reduce risk

4.1 ACCIDENT SAMPLE

Table 10 provides a breakdown of the accidents studied by construction sector. It can be seen that major building and civil engineering were over-represented, while the residential sector was under-represented against the original targets. Nevertheless, the accidents examined encompassed the range of industry sectors.

Table 10 Distribution of accidents studied (n=100)

	Engineering construction	*Civil engineering*	*Major building*	*Residential*
Target	5	15	45	35
Result	4	25	49	22

There was wide variation in the nature of build and organisational details of participating sites, ranging from short contract work to major building projects, being undertaken over a number of years. All but 16 of the sites were brownfield (4 unknown/missing data).

Sites varied considerably in size, accommodating between 7-2500 personnel and with build schedules varying between 1 week to more than 10 years. From the 100 accidents, 71 projects were reported to be running to time, 1 was ahead and 18 were behind schedule (10 unknown/missing data).

Four of the sites were undertaking concurrent phases of their work, whereas 11 were in the ‘start’ phase, 58 in the ‘middle’ phase, 9 between ‘middle’ and ‘end’ phases, 7 in the ‘end’ phase and 2 in the ‘after’ phase (9 unknown/missing data). The remaining 4 projects were refurbishment.

Many of the main UK principal contractors were represented. The contract types were as follows:

- design and build / contractor led – including residential developer build (n=31)
- integrated, eg partnering / PFI / alliancing (n=24)
- lump sum / fixed price / design then build (n=14)
- construction management (n=13)
- other contract types (n=4)
- unknown i.e. not identified in the accident study (n=14)

It was not possible to gain adequate detail relating to project value and company employee numbers to enable comparison and this information is therefore not reported.

4.2 ACCIDENT CIRCUMSTANCES

Twelve of the 100 accidents should have been reported under RIDDOR (but were not necessarily actually reported as such). Of these, three were dangerous occurrences, eight resulted in absences of over 3-days and one was a major accident. The sample accidents are reported according to the HSE categorisation in Table 11 (revised to combine slips, trips and all falls data together) with an additional category for 'injuries directly involving materials, tools or equipment'.

Table 11 Distribution of accident types (n=100)

Category	*Accidents number reported*	*Total*
Slips, trips and falls (all levels)	16, 17, 23, 36, 37, 46, 47, 51, 53, 54, 55, 58, 62, 64, 73, 75, 77, 81, 86, 88, 100	21
Injured while handling, lifting or carrying	5, 14, 15, 28, 29, 31, 33, 34, 38, 39, 48, 50, 56, 57, 76, 83, 84	17
Struck by moving (+ flying / falling) object	1, 4, 9, 19, 24, 32, 35, 43, 44, 61, 63, 68, 69, 78, 89, 93, 96, 97	18
Injuries directly involving materials, tools or equipment	7, 26, 30, 49, 59, 74, 80, 87, 92, 95, 98, 99	12
Strike against something fixed or stationary	6, 18, 21, 22, 25, 27, 82, 91	8
Dangerous occurrences	3, 10, 11, 20	4
Contact with/by moving machinery	2, 12, 13, 42, 85	5
Trapped by something collapsing or overturning	60, 65, 70, 72, 90	5
Contact with electricity or electrical discharge	52, 71	2
Other accident event types	8, 40, 41, 45, 66, 67, 79, 94	8

4.2.1 Pattern of activities and involved items

The pattern of involvement of tools, equipment and materials / structures, along with the nature of the task or activity being undertaken at the time of the accident are given in Table 12.

Table 12 Activities and involved items within the accident sample (n=100)

	Tools	*Plant / equipment*	*Materials*	*Site / structure*	*Total*
Setting-up		31, 42, 74	34	16, 67, 73	7
Actual task activity	2, 3, 7, 13, 14, 26, 30, 39, 49, 59, 65, 87, 89, 97, 99	8, 11, 29, 38, 60, 71, 94, 79	5, 9, 10, 15, 33, 35, 40, 43, 45, 48, 57, 63, 80, 84, 95, 96	20, 24, 27, 28, 52, 55, 58, 61, 77, 78, 91, 92, 93	52
Clear-up / maintenance	98	4, 12, 21, 32, 46, 56	54, 66, 70, 83	82	12
Movement / transit	50	6, 17, 19, 22, 36, 37, 41, 51, 62, 85, 90	1, 25, 44	18, 23, 47, 53, 64, 68, 69, 72, 75, 76, 81, 86, 88, 100	29
Total	17	28	24	31	100

The location of 25 accidents was indoors and of the remainder that occurred outdoors, adverse weather conditions (ie damp, wet or wind) were reported in 19 accidents.

With regard to working height, 71 accidents happened at basement or ground level, with the remainder occurring at height. Of the latter, 3 accidents featured some form of level change.

4.2.2 Accident-involved individuals

Interviews were undertaken with 100 accident-involved individuals (mean age 35.5, standard deviation 12.2, range 17-62 years). Table 13 provides descriptive data for the sample.

4.2.3 Timing of accidents

The month, weekday and time at which the accidents occurred are summarised in Table 14. The sample encompassed accidents across all seasons, with the majority taking place between the hours of 08.00 and 17.00. Of the 15 other accidents, for 13 the time of day was unknown, one happened in the early hours of the morning at 01.30 and the other at 18.30.

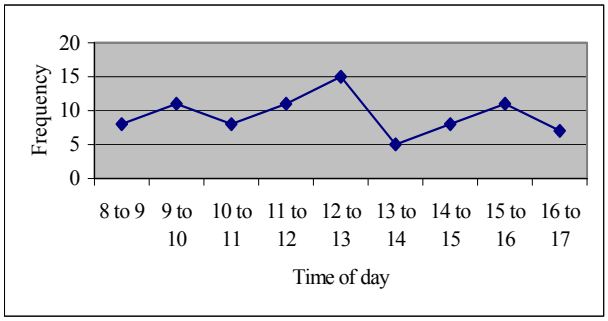
Table 13 Details of accident involved individuals (n=100)

	Accident involved individual on site (n=100)		
	Unskilled operative (n=27)	***Skilled/semi-skilled operative (n=60)***	***Other (n=13)***
Job titles (examples)	labourer ground worker fitters mate hod carrier	joiner glazer bricklayer electrician duct worker lorry driver pipe fitter scaffolder	site manager engineer brickwork manager trainee manager foreman
Age	32.7 (10.7) 18-57	37.2 (12) 17-62	32.8 (15.2) 18-57
Duration on site (months)	4.3 (6.7) 0.5-36 *(n=26)*	6.2 (7.8) 0.25-36 *(n=53)*	6 (2.9) 2-11 *(n=11)*
Duration in industry (years)	10.4 (10) 0.33-38 *(n=24)*	18.1 (12.1) 0.8-46 *(n=54)*	14.7 (16.7) 0.08-42 *(n=12)*
Duration with employer (years)	1.7 (4.1) 0.04-18 *(n=19)*	3.9 (5.2) 0.08-22 *(n=47)*	5.9 (11.1) 0.08-42 *(n=13)*
Average designated hours / week	42.7 (5.5) 35-60 *(n=27)*	42.4 (5.5) 26-55 *(n=59)*	45.9 (8.6) 35-65 *(n=13)*
Number able to specify weekly overtime hours	11	33	8
Average hours of OT per week (where specified)	10.7 (13.5) 4-38 *(n=6)*	5.1 (2.9) 2-12 *(n=12)*	5 *(n=1)*
Daily travel time to work (oneway-mins)	41 (23.4) 5-90 *(n=25)*	34 (23.6) 5-90 *(n=58*	40 (28.9) 5-120 *(n=13)*

** mean (sd) and range presented in all cases*

Table 14 Timing of accidents (n=100)

Month	*No*	Day of the week	*No*
Jan	7	Monday	15
Feb	2	Tuesday	20
Mar	6	Wednesday	21
Apr	11	Thursday	21
may	8	Friday	9
Jun	17	Saturday	5
Jul	16	Sunday	1
Aug	6	Unknown	8
Sep	5		
Oct	5		
Nov	7		
Dec	6		
?	4		



4.3 ACCIDENT CONSEQUENCES

As explained earlier, the limitations on the accident sample meant that most of the accidents studied were not reportable under RIDDOR. In order to consider the extent to which the research findings are transferable to more serious incidents, an analysis was undertaken to assess potential outcomes (Figure 4). These have been classified as 'likely' or 'possible' based on the RIDDOR classification and are recorded in Appendix C. This rationale is based on an evaluation of the incident information and evaluation of alternative outcomes if the injured person had been in a slightly different location or if a different part of the body had been involved. Likely outcomes would have required only a minor change in circumstances; possible outcomes would have required a number of circumstances to change. Some of the 'major' incidents may have led to permanent disability and hence loss of the individual to the industry.

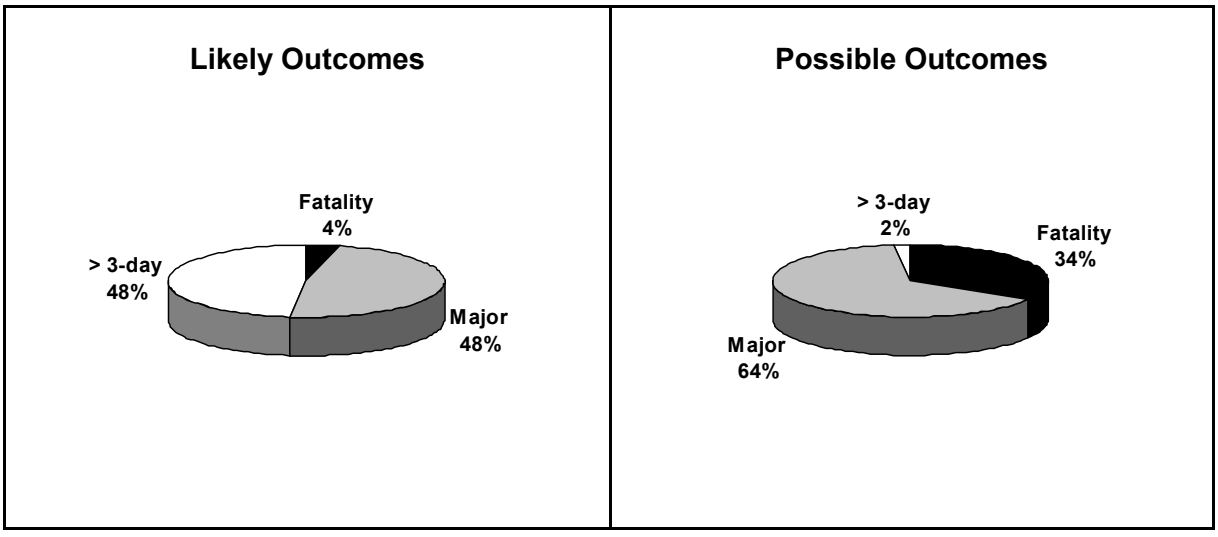


Figure 4 Likely and possible accident outcomes

Had the situation varied only slightly, it is possible that almost half of the accidents could have resulted in absences of more than three days and almost half could easily have been major incidents. Between 4 and 6 accidents could have resulted in fatalities looked at on this basis. Considering a worse outcome, more than a third of the accidents were judged to have had the potential for a fatality and more than two thirds could have been major.

4.4 ANALYSIS OF CAUSES

Appendix D gives a simple analysis of the causes of each accident, based on the information collected during the site visits. A summary of the findings is presented in Table 15.

This analysis was performed by the researchers, based on their judgement of 'reasonable confidence' that a factor was causal in an accident. It should be borne in mind that it is easier to be confident concerning the involvement of more immediate factors, eg worker actions or site hazards, than wider influences, such as safety culture. This is because the action of the immediate factors is direct and more obvious, while the involvement of other influences is more subtle. Possible involvement of such 'upstream' influences is investigated in the subsequent results sections.

Table 15 Summary of accident causes

Category	*Causal Factor*	*Number of accidents*	
Worker & Work Team	worker actions/behaviour	49	
	worker capabilities (including knowledge/skills)	42	
	communication	7	70
	immediate supervision	13	
	worker health/fatigue	5	
Workplace	site conditions (excluding equipment, materials, weather)	11	
	site layout/space	15	
	working environment (lighting/noise/hot/cold/wet)	9	49
	work scheduling	11	
	housekeeping	19	
Materials	suitability of materials	12	
	usability of materials	8	27
	condition of materials	13	
Equipment	suitability of equipment	44	
	usability of equipment	19	56
	condition of equipment	12	
Originating Influences	permanent works design	27	
	project management	24	
	construction processes	12	94
	safety culture	15	
	risk management	84	

It may be seen from Table 15 that 70 of the accidents had the worker or the work team as a contributing cause; almost half included the workplace; more than a quarter had materials as a

factor; more than half implicated equipment and almost all identified originating factors as significant, especially risk management.

The categories from Table 15 have been used to organise the discussion of the results from the accident studies. Where possible, specific accident numbers have been added in brackets as examples of the points being raised. These examples are not intended to be exhaustive.

4.5 WORKER AND WORK TEAM FACTORS

It can be seen from Table 15 that a failure by the worker or within the work team was considered to be a causal factor in 70 of the accidents. Worker or work team factors in construction accidents involve the actions of individuals, their capabilities and communication problems. Possible influences on these arising from worker attitudes and motivation, pay and remuneration, supervision and deployment, education and training, health, and working hours are considered in the following sections. The term 'worker' is used broadly and includes operatives, trade personnel and specialist professionals.

4.5.1 Attitudes towards safety

A wide variety of views were heard in relation to health and safety within the industry. Although there was no real rejection among interviewees of the need to 'be safe', perceptions of what constituted safe and advantageous varied.

Some interviewees thought the prescription of 'safety measures' as detrimental to performance, by slowing the job down (60) and reducing earning potential (2, 17). There were a small number of isolated responses to the effect that some special measures (such as special risk assessments for young people or anti-vibration gloves) were 'over the top' (52). Others mentioned that safety measures sometimes introduce new risks (52) (eg. safety barriers creating trip hazards or harnesses hindering safe escape in emergency situations). Also, the view was expressed that increasing implementation of safety measures had led to relinquishment of personal responsibility for safe working behaviour (21, 52).

> … People lose their wits because of regulated safety …

Others felt that some general safety measures were unnecessary. The blanket policies on all sites about the wearing of PPE (hard hat and harnesses especially) were considered by some to be inappropriate to a range of work circumstances (23, 18). Interviewees suggested that this stipulation undermined their ability to make informed decisions (as to the safety of any given work situation) and was also an insulting intrusion into their otherwise high risk, high responsibility roles.

Use or non-use of PPE was reported by operative and supervisor/manager interviewees alike as one of the main indicators of safe practice (41); yet there was irritation among some operative interviewees that focus on this was at the expense of concentration on less visible but greater hazards (1, 62).

> … We're forever getting told off by the principal contractor about things not done. It's over the top, like complaining about you taking your hat off if it's in the way – they go on about minor things, but the major stuff is all down to money …

There was mention of working safely when the safety advisor was around, with instructions to resume 'normal' practice when they left (23).

Conflicting views were offered regarding young or trainee workers. From one perspective they were seen to be more safety aware (22, 25). Other indications were that inexperience, reluctance to complain, and picking up poor habits and attitudes from older and more experienced workers rendered them less likely to act on this knowledge (2, 5, 17, 20, 25).

4.5.2 Providing motivation

A range of practical schemes were described. One principal contractor interviewee's company awarded a monthly prize (£100) to the best sub-contractor team (judged upon their management procedures, safety performance and adherence to method statements and risk assessments) (25). Where poor performance or unsafe work was observed, sites reported various disciplinary measures such as work supervision and warnings prior to dismissal.

Across sites, motivational methods included financial incentives to meet target dates (25, 64), 'job and knock' (especially on Friday's and weekend work) (4, 12, 20, 23, 34, 37, 52) and increased hours or double shifting (25), however 'job and knock' was not necessarily believed to compromise safety (20).

> … We did 'job and knock' as the site really wanted to get the work done …

In one instance, it was suggested that the absence of sick pay and fear of redundancy acted as incentives to work safely (51).

4.5.3 Pay and remuneration

Most interviewees received either salaried (for permanent employees) or fixed wage payments. Fixed wage payments were most common among interviewees at operative level and those on site for a transient period only. Only two operative interviewees received priced work payments (4, 63), yet it appeared that the pay for a number of managers or supervisors from smaller sub-contractors may have been interlinked with the fixed price of the work contract and performance bonuses for work completion (25, 34). When describing payment preferences interviewees, for the most part, indicated a preference for fixed wage arrangements (9, 19, 18, 20, 21, 22, 33, 36, 38, 50, 60, 61).

> … At 31 I'm getting too old for priced work now …

> … priced work isn't good if delivery of equipment is late …

> … there's less stress and you don't have to take so many risks to earn more …

Those with a safety role were critical of priced work for conflicting with safe working practice (2, 11, 13, 22, 25, 36, 37, 63).

Some of the interviewees would have preferred priced work, however, because of the increased earning capacity that this method brings (4, 5, 23, 40, 52). One interviewee reported that priced work was more likely at the weekends (61).

> … It would be very hard to get a bonus on this type of site, but I can go faster on house building work as it doesn't have to be perfect …

A small number of alternative payment methods were also described, such as a share of the bonus scheme for finishing work quickly or for working through the rain (34, 52). One interviewee received a loyalty bonus of time off equivalent to 4 weeks sickness absence per year (64).

4.5.4 Supervision and deployment

The level of responsibility within the supervisor role varied across interviewees. Some had responsibility for overseeing a large number of people, up to 20 in one case (36), while other supervisory positions were more informal (20, 34, 40). Promotion to a management or supervisory role from a skilled operative position was not always welcome (62).

In discussing their supervisory style, some interviewees described the need for a firm approach to ensure that work progressed (9, 20, 52) and that correct PPE was worn (40).

> … I have to stand over and drive them - if you don't then they don't do it …

> … The lads just don't see the danger and therefore they need to be told and kept in line …

Demands on supervisors are added to by various dissatisfactions, such as the need to assess and oversee the performance of new operatives (9), concurrent demands of dealing with mobile phone calls, averaging 20-30 per day for one interviewee (2) and with long working hours.

In practice, many operatives appeared to organise their own tasks and workload (2, 7, 9, 13, 18, 22, 23, 61). This appeared to be especially the case with the self-employed or those engaged in a specialist trade (23). Close supervision was thought to be inappropriate for experienced workers (both by operatives and supervisors/managers alike), many of whom might have held a supervisory role themselves on other sites or under different circumstances (2, 4, 13, 52, 53).

Sometimes, problems occurred when experienced operatives undertook tasks which were 'one-offs' and with which they were unfamiliar, such as covering labourers' work due to human-resource shortages (12, 20, 21, 39, 60, 61, 84, 85, 90, 96). This may arise due to a need to accommodate unplanned work, perhaps as a consequence of fluctuations elsewhere on site, owing to shortages in labour or resources (2, 19). In accident 2, for example, a stock of window braces was being made up because extra bricklayers had unexpectedly been appointed to site (using up the existing supply) and because a shortage of carpenters was anticipated in the following few days. Not all assistance is altruistic, however, as there was one report from a supervisor who chose to take 'the risk' himself as a measure to avoid having to do any paperwork (21).

Other issues relating to inexperience were observed (although were rarely reported as problems by study participants themselves). Amongst these were apparent difficulties keeping up with a fast work pace (5, 12, 40) and sometimes a reluctance to request assistance or a break when needed (40, 50).

In putting together a team of workers, supervisors/managers aimed to avoid disruption of established gangs, where there was often strong cohesion. In some situations there were family connections or a history of longstanding co-working (2, 5, 34, 50). Where teams had to be made up they would aim to mix experienced with inexperienced employees, although this was not always possible (12, 19).

4.5.5 Communication

Interviewees reported that communication beyond their own peer group was limited (37, 38) and that there was a certain amount of sectorial behaviour (20).

> … It's the brickies versus the chippies and then M&E versus everybody else …

There also appeared to be an undercurrent of dissatisfaction between different employee groups. At times this was interlinked with dissatisfaction with the housekeeping of another trade, or was

related to poor performance or behaviour of others that the interviewee felt had induced the accident event (4, 11). Additional friction was apparent between (non-grade dependent) employee groups, distinguished by age, language and literacy.

Issues relating to language and literacy also arose in some accident studies. There were reports of communication problems due to non-English speaking co-workers in a small number of the accidents.

> … I had a full trolley of plasterboard and was wheeling it along the gangway with help from a foreign labourer. There were communication problems. If the other man could have understood 'stop pushing' instantly it probably would have helped prevent the accident …

It was reported that language and literacy affected communication of safe working practice (8, 19, 22), yet there was some reluctance to address this as a safety matter, for fear of being accused of racism. Communication problems through poor literacy were also described or apparent (12, 24), although there were few reports of disadvantages from this. Where relevant, any difficulty was accommodated by reading out or describing the instructional materials. One supervisor/manager interviewee reported using the induction process to confirm language and literacy skills (23).

4.5.6 Education and training

Many interviewees were unable to provide details of education and training history at the time of the interview. However, of those who were able to provide some details, it appeared that for a sizable minority of these, toolbox talks and inductions were their only source of training. While operatives in trade positions had often undertaken apprentice or City and Guilds training, further training for them and others in labourer positions was focused upon CSCS or 'ticket' based training for use of site plant or equipment. Many interviewees reported having received no particular training for undertaking the accident event task (9, 17, 19, 20, 22, 24, 34, 35, 38, 40). In some cases this was because the accident had occurred during non-task activities, such as movement around site, or because they had learnt how to perform the task through a variety of informal methods.

There were, however, differing perceptions between those in operative and supervisory/ managerial roles as to what constitutes training. In a number of accidents the supervisor/ manager reported that training (eg toolbox talks, induction, task technique) had been provided to the accident-involved individual. Discussions with the indicated recipients, though, often revealed that they did not see things this way (17, 20, 22, 40, 61). Informal site based instruction or toolbox talks were least likely to be perceived as training (65).

> … I've never had any safety training … *(then, later in the same interview)* … I had a toolbox talk this morning 'How to walk safely on site' – it was OK …

Mistrust or trivialisation of training was also observed, with comments implying that it is a means of satisfying health and safety rules rather than as a method of skills development (20, 38). In accident 5, for example, it was reported that the supervisor provided manual handling training to the accident-involved interviewee, after which they then proceeded with the manual lift in spite of the extreme load and mismatch of team handlers.

An interesting observation is the value given to obtaining a trainee's signature. In many instances, interviewees reported 'signing for it' after receiving some type of information (1, 5, 9, 25, 50, 51, 61, 62). Some interviewees described this then being used for reprimanding rule breaking (37) or as a disclaimer of responsibility by those in authority (4, 5, 9).

Training schemes

Interviewees reported having undergone a variety of baseline trade, apprentice and NVQ training schemes, generally undertaken as school leavers and supplemented with subsequent experience on the job (1, 2, 7, 11, 18, 22, 23, 51, 61). The styles and duration of these different types of training was varied and appeared to involve a mix of college and practical based experience.

Among the few trainee participants interviewed, a number of problems were reported. Scaffolder training, for example, was described as two to three block-release sessions at a training centre, with examination after each, this subsequently permitting a certain level of unsupervised work. The formal training was supplemented with ongoing 'on the job' learning and supervisor assessment. Interviewees in a trainee role expressed concerns about the quality of 'on the job' learning, citing inconsistency of standards and lack of enthusiasm among the training providers (17, 23).

> … The training involves labouring with scaffolding thrown in if they can be bothered …

A range of titles are given to the various stages of trainee development (from 'mate' to 'improver' for example) and the rationale for determining promotion intervals appeared flexible, lacking formal time scheduling or criteria for decision making of skills achievement (17, 24). Employers and the self-employed both reported paying for such training provision.

CSCS training

Interviewees described experience of CSCS training schemes, lasting between one and five days. Typically these involved training for use of a particular piece of plant or equipment (eg scaffold tower, mobile equipment, fork lift truck) or for supplementary safety training for their trade or area of responsibility. The CSCS scheme, with each training and assessment session referred to as a 'ticket', was well established on many of the sites visited and was used as a formal method by which to determine competence of workers to operate on site.

Some unfavourable comments relating to the CSCS scheme were made, concerning a perceived overemphasis on classroom style instruction compared with the practical component of a training course. A novice user of an item of motorised mobile equipment might complete and attend a full day training course for example, but the time spent on practical training for the 'ticket' did not then provide sufficient experience for using the equipment unsupervised on site.

> … The crane co-ordinator course I had was not training – it was just here's the form, fill it out and sign it …

On the job learning

Interviewees also reported that their skill development also occurred through less formal (and unassessed) methods, such as practical experience from working on their own (5, 20, 40, 60), and by 'on the job' learning.

> … I do this job six days a week, and you can't get any more trained than that …

> … I haven't had any training – its just something you pick up isn't it …

'On the job' training had been the sole method of skills development for those whose work was not a formally recognised trade, such as groundwork (52), ceiling fixing and ductwork (22, 24, 34), although it was reported that efforts are being made to develop an NVQ system for duct workers. Interviewees from these groups indicated they were dependent on the ability and

goodwill of their co-workers or supervisors in learning the necessary skills (9, 22). Some also felt that their expertise was underestimated (22, 52).

Supplementary training

Paper-based training methods were regularly used for supplementary training, including conveying information. Approaches included use of booklets or leaflets on general health and safety information, manual handling training techniques, site inductions, toolbox talks, method statements and risk assessments. Where paper-based methods were used, it was reported that interviewees would either be given the material to read themselves, or that this would be read out to them (often during inductions).

Use of other training mediums, such as video or case histories, seemed infrequent (53) and there were concerns that the training messages were lost because of use of inappropriate interface styles for the target audience (25). Interviewees who held supervisory positions, which included acting as training providers, commented on the lack of training that they had received to undertake their own training role. Mention was made of their own needs for training in safety and management, and in the provision of toolbox talks and inductions (1, 40, 52).

Site induction

Both positive and negative comments were received about site inductions. Positive reports concerned the value of induction to introduce information unique to the site and also to inform newcomers about necessary emergency and health and safety information (40, 52, 64). On the other hand, other interviewees reported that site inductions offered no value (9, 22, 23, 25, 34, 37, 40, 50, 51, 52), citing reasons such as 'its all common sense' (2, 36, 38), that they fail to stimulate attention (18, 38 52) and that they 'tell you what you already know' (5, 34). Others found them a time consuming formality to enter site (6, 36), appropriate for specialist sites only (61) and complained that they cover issues (such as drugs/alcohol) that those running the inductions are not qualified to make a judgement upon (40).

Interviewees described a variety of different styles of site induction, ranging from a single sheet bullet point list of information, through to mixed media including a range of video presentation, discussion, pictorial and paper-based methods. When describing preferences for presentation style, interviewees both liked (19) and disliked (64) video methods, but were less keen when they had to read information themselves (51). Inductions varied in length from thirty minutes up to two days on some of the larger aeronautical or petro-chemical sites. For some interviewees, induction was reportedly one of their only sources of safety training (34).

Induction was recognised by some as training (17, 61) but not by all (24). Issues such as Weil's disease, needle-stick injuries, and fire and muster points were remembered content (17, 18, 51). Others found inductions to be too long or difficult to take in (17, 19). Some interviewees reported that the induction contents were not appropriate for their work, such as those undertaking delivery driving or who were specialist tradesmen (2, 11, 18).

> … They're not any value when you've had so many – I just need to know if the site varies from others. They're not really to do with scaffolder's work …

Toolbox talks

Many of the operative interviewees received toolbox talks and there were varying views as to the value of these. Positive comments were received, although it was acknowledged that it was difficult to try to make these stimulating for longstanding employees (36). More negative reports concerned inability to remember the topics that had been addressed in toolbox talk training (40, 62), use of tool box talks as a way of controlling misdemeanours (such as going home early) or as a reprimand for a failure or accident (22, 36).

Determining competence

All the sites visited for the research were managed by members of the Major Contractors Group and it was policy that appointees at trade level should be holders of a CSCS card. The company Head Office occasionally made this verification (22, 60, 61), or otherwise it was undertaken on site. Nonetheless, supervisor/manger interviewees, when asked how they determined competence of new appointees on site, reported a range of additional approaches. These included review of where applicants had worked before or obtaining an opinion about them from a previous employer (19, 36). Alternatively, they reached a decision by talking with them at induction (19) or by watching and reviewing workers once they had started work. An impression would often be reached within the first few hours on site, with at most up to a week or two trial (17, 19, 20, 33, 37, 63). A principal contractor interviewee indicated that it was the responsibility of the sub-contractor to ensure appointment of competent personnel (22).

4.5.7 Operative health

Interviewees variously reported both good and bad health. Where there were reports of previous or existing health conditions these included musculoskeletal injuries (4, 13, 17, 21, 22, 23, 28, 29, 40, 48, 60, 63, 64), respiratory problems (23, 53), eye problems (23) and feelings of stress or anxiety (1, 25). In most cases these did not appear to be directly relevant to the accident being studied, however, in accident 37, a pipe fitter caught his foot in trailing cables and aggravated an existing problem with his knee. In another case, accident 48, an operative was laying out Geogrid membrane. The operative over-exerted himself when the membrane became snagged, causing a musculoskeletal injury at his shoulder. This was the site of an old injury, sustained whilst playing sport.

Supervisor/manager interviewees were asked to describe arrangements for pre-placement health screening. Some interviewees thought that nothing existed (63), although others reported that health requirements were stipulated for working in confined spaces (38, 62). Otherwise, there appeared to be no formal processes. Usually, it seems that decisions about fitness for work are made by the safety officer, contracts manager or director (40, 50, 60), or are dealt with by whoever provides the site induction (40, 50).

Some interviewees described the health surveillance available through provision of an annual medical (36, 51, 61). Mention was made in one case of the availability of discounted rates for a local gym (37).

4.5.8 Working hours

The average working hours of each employee group have been given previously in Table 13. Interviewees in many of the accident studies reported long working hours (1, 2, 3, 4, 5, 11, 19, 21, 22, 23, 25, 33, 36, 37, 50, 61, 64, 99). Weekend work was undertaken by many interviewees and appeared to be accepted practice. In one case it was seen as beneficial to spread the workload over seven days rather than five (61).

Many employees worked in excess of 40 hours per week and working hours, on average, were greater among those in safety/managerial or supervisory roles (5, 20, 23, 61, 62, 64). Whilst safety and managerial staff appeared less likely to undertake ‘overtime’ as such, they also described additional working hours as being an inherent part of their workload, perhaps completing paper work at home at the weekend or, especially for managerial staff, feeling the need to be on site whenever operatives are working (64). Few described their additional hours as overtime as they felt that such arrangements were inherent to their appointment and salary agreements.

Interviewees in the operative or supervisory grades saw overtime as distinct from their formal working hours. In a small number of cases, operatives undertook supplementary work away

from the site. In some instances, interviewees felt that overtime was pressed upon them and something that they could not decline (11, 25, 40, 50, 60). Another respondent suggested that undertaking overtime was habitual rather than something that he really needed to do (13). One interviewee described the ability to undertake up to 30hrs overtime per week, beyond which the pay incentive was reduced (21).

Interviewees also reported the requirement for considerable flexibility in working hours, if this was dictated by the process (a concrete pour for example) (11, 12, 40). The need for flexibility meant that the provision of breaks was not always honoured. Lengthy work periods without rest were reported (especially in the afternoon). Interviewees occasionally accepted (21) or more usually showed dissatisfaction with this arrangement (11, 12, 21, 22, ,23, 24, 25, 33, 40). On other occasions, however, interviewees were happy to forfeit their break in order to complete work and leave earlier at the end of the day (4, 12, 34, 37, 64).

Many interviewees also reported working long distances from home (2, 4, 7, 9, 20, 21, 22, 40, 52, 53, 65). A number of interviewees started their day and commenced travel to work between 04.45 and 06.00, to arrive on site at any time from 06.45.

Reports also varied when interviewees described their arrangements for sickness and holiday pay. A number of operatives said that there had been occasions when they had taken sick leave and had not been paid for this. This acts as a disincentive to take rest in the case of minor illnesses (34). Unpaid holiday was also reported by those in both labour and trade positions. Even among those who received paid holiday, labour, trade and ganger grades took the least time off on average, with some taking little or no time off at all (18, 33, 40, 50, 53). There were some reports of taking pay in lieu of holiday (50, 52).

4.6 WORKPLACE FACTORS

The workplace was judged to be a causal factor in almost half of the accidents. Workplace factors influence safety through the presence of local hazards, adequacy of working space, environmental aspects such as lighting, noise, vibration and impact of the weather. These, in turn, are affected by constraints of the particular site, consequences arising from work scheduling and effectiveness of housekeeping procedures.

4.6.1 Site layout

Insufficient working space was a problem reported in a number of the accident studies (2, 7, 11, 17, 25, 53, 62, 85). In one case it was felt that the space allocation was hindered by commencement of the build prior to the completion of demolition. This resulted in a number of later reorganisations of site layout to accommodate the changing plan of the build. More general discussion highlighted how space constraints restrict the allocation of floor area for workshop placement, footpaths, storage (especially important in winter when work is rained-off), parking provision, and adequacy of space for transport routes. It was reported that the latter manifests itself in constricted room for vehicle manoeuvrability and difficult access to drop-off points, Figure 5. This has a knock-on effect on the ease of receiving deliveries and can result in a subsequent need for double handling of materials. Problems with transport routes between different levels were described, involving narrow routes for lorry access or lack of lifting equipment to hoist smaller items between levels (11, 50).

With regard to local working space, problems arose from limitations of the area available for movement and manipulation activities (2, 3, 12, 20, 60, 85, 86, 91), inadequate working height or inappropriate work surfaces for materials or equipment placement (7, 39). Alongside space limitations were the presence of structures, such as scaffold bracing and protruding structures, impeding free movement (18, 36, 50).



Figure 5 Dangerous occurrence involving access and space constraints (11)

The need to accommodate the space requirements of other workers caused problems in several instances (4, 5, 13, 23, 24, 25, 36, 51, 52, 53, 60, 93).

> … Most jobs are fast track programmes and you end up working on top of one another …

The descriptions provided by interviewees indicated that this was an accepted and normal part of their work, yet the impressions of the researchers were that this affected ease of access and induced operatives to increase their work pace if others were waiting for them to finish or to gain access to an area (5, 23, 24).

Another problem that can arise from the site layout is difficulty communicating due to the physical distance between a group of co-workers. Examples included coordination of concrete pours between different levels (12) or negotiating the desired delivery quantity when the outlet was at some distance from the flow control source (40).

Interviewees also mentioned problems arising from the provision of incomplete drawings for external services such as electricity. This was said to be a common problem, with live cables often unmarked and hazardous during groundwork (52).

4.6.2 Ground conditions

Interviewees reported many situations where ground conditions were a contributory or risk factor for accidents (1, 17, 22, 37, 47, 51, 52, 62, 63, 64, 67). Common problems were raised structures on the walking surface, creating trip hazards. In accidents 17, 37, 51 and 64 for example, the trip hazards were electrical cables (Figure 6), ply board used as a temporary manhole cover and raised setting out points. These items were coloured either black, (steel) grey or brown and protruded less than 50mm above the surrounding floor surface.

> … If the points had been marked or coloured then I could have seen them better, but they are steel discs, which is like a camouflage…

In other areas, terrain was more uneven and precarious for walking over, such as when working on reinforcement mats, loose ground or brick rubble (1, 53, 73, 75, 88). The condition of traffic routes and walkways were also frequently mentioned as being hazardous (eg 51, 76).

> … There is always brick dust, which is a slip hazard, but when block work is cut the debris is like roller-balls under your feet …

Problems mentioned included partial obstruction of access areas or footpaths with debris, deliveries or traffic cones (17, 62, 64). Allied to concerns about pedestrian movement was the effect that ground conditions have on the safe movement or stability of mobile equipment, such as lories, hoists or scaffold towers (11, 50, 60). Surface hazards such as spilt oil, mud, cement or wetness were also reported (22, 40, 52, 62).



Figure 6 Presence of trip hazards (17)

4.6.3 Environmental conditions

Although many operative interviewees mentioned poor weather (eg cold, wet or windy) as one of the worst parts of their job, they rarely appeared to see this as having any direct implications for performance or accident risk. Accident-involved interviewees were asked about adverse environmental conditions and mention was made of poor lighting and dusty working conditions. There was one report of distracting glare from sunlight reflecting on concrete (18), with other instances involving inadequacy of lighting in terms of availability and task illuminance (2, 37, 50, 51, 63, 64). Excess dust was said to be a problem during general clearing up and by interviewees involved in ductwork.

4.6.4 Housekeeping

Poor housekeeping was raised as an issue by many interviewees (2, 22, 23, 24, 50, 51, 61, 67, 70, 81). Allocation of responsibility for clearing up was seen variously as something they would expect other gangs (who had created the problem) or the principal contractor to undertake. Situations were described where rubbish was pushed to one side or work schedules delayed due to a need to clear up after others (24, 51, 53, 64). Some highlighted that the weekly delivery of an empty skip provided the opportunity for a clear up, its predecessor being too full to take any further material long before it was exchanged. One interviewee, however, felt that he was less careful when the work area was overly tidy.

4.6.5 Welfare facilities

Responses were mixed when describing the provision of welfare facilities. Many were happy with the facilities, but a number of operative interviewees expressed dissatisfaction. Most

complaints concerned the provision of insufficient numbers of toilets (22, 25, 60, 61, 64), and their dirty and smelly condition (22, 24, 62, 64). Shortcomings with washing facilities were also discussed, including inadequacies in water pressure, supply of grit soap (5, 6, 9), and a lack of shower facilities (11, 25, 37, 52). Whilst complaints about changing room facilities were fewer (9, 37), there was concern about lack of security, with reports of lockers having been broken into (65).

With regard to refreshment provision, most seemed satisfied with availability of food and drink, but there was a complaint about access to fresh drinking water (8). This is an issue due to health risks associated with regular dehydration. Dissatisfaction was expressed concerning pressures on use of the canteen at break times, with queuing reducing break allowances, and lack of space resulting in some having to eat in the changing rooms (23, 52, 39, 64).

4.7 MATERIALS AND EQUIPMENT

Material and equipment characteristics considered by the research included their suitability, usability and condition (including maintenance). Factors influencing these are the material/equipment design, specification and their supply and availability. Material and equipment design are also considered further in sections 4.9.2 and 4.9.4.

4.7.1 Materials

Issues with construction materials featured in 27 of the accident studies. One problem was variability in the quality of materials. The following interview extract relates to accident 1, where an operative suffered an eye injury when engaged in rebar tying work.

> … When the coils of tying wire are heated in the vat (annealing process) the ones at the top don't get heated so much – this makes them stiffer and more springy … you can't really tell what its going to be like until you start to use it …

Another aspect concerns hazards present in the way materials are received for use. In accident 9, for example, steel banding securing a delivery of plywood caused a laceration. This type of packaging can also be a fall hazard if not disposed of adequately (88). Cut hazards were also reported in connection with metal ducting, with the problem made worse by the material being slippery due to a protective oil coating (34). Heavy loads were a factor in several accidents (eg 1, 5, 18, 22, 33, 50, 84). While interviewees made occasional comments about this problem, there seemed to be general acceptance of heavy lifting as part of their work.

> … There were ten steel angles to be unloaded from the forklift truck onto the storage point on the floor… with a man at each end we expected to take about 20 minutes to do this…

In this accident (5), for example, each angle was 9m long and weighed 140kg, an inappropriate load to be moved manually. In some other incidents, the presentation of materials did not lend itself to good handling practice, perhaps due to slipperiness of the product (as described above) or with inadequate contact area for grasp or purchase (1, 33).

Interviewees were also concerned about the limited information from manufacturers concerning use of the product (2, 13, 22) and, on one occasion, of the possibility of contamination of materials with rat urine (1).

In one case (71) an electrical pump being installed within a heating system was faulty, resulting in an electrocution.

> …basically, it was a wiring problem – a design fault that was overlooked by the manufacturer – the push-in electrical socket was put in the wrong way by the apprentice electrician, making the appliance 'live'…

The use or introduction of new materials was discussed in follow-up interviews with material designers /suppliers. It was apparent that on some occasions, differences arise between material designers' anticipated application of their products and how they actually get used on site. In accidents 2 and 39, for example, cavity closure window frames and a slewing ring were fabricated or used in a manner not intended by the designers. From another perspective, it was suggested that there is sometimes a rejection of innovations by site foremen, due to a reluctance to change.

4.7.2 Tools

An assortment of tools featured in the accident studies, ranging from simple hand tools through to more sophisticated or powered tooling.

Shortcomings in function or performance were reported by interviewees (2, 52, 98), with further problems with tool design observed by the researchers. Typical failings included poor grip characteristics, undesirable pressure at skin contact points and, for powered tools, frequent use of finger trigger operation (1, 7, 35, 65, 99). Some tools also appeared heavy, given the situations in which they were being used (95, 97). For example, the petrol saw and torque multipliers used in accidents 20 and 39 each weighed 11.5kg and 8.9kg, heavy loads when used in awkward postures. It was observed that attempts to reduce problems with tools had been made by users through the addition of padding or tape on handles. Bladed tools required frequent unprotected handling of the cutting edge to change blades (7) or to remove obstructions (2). One accident involved an electrocution due to problems with the performance of a CAT scanner (52). Time saving seemed to be an issue in tool use for other accidents (20, 33, 50).

> … A kerb lifter is available, but by the time you go and get it it's easier to use two people at each end …

> …The saw was quite a heavy and bulky tool for cutting the pipes, but a handsaw would have taken forever …

Interesting comments were made about criteria for tool purchasing. The self-employed often provided their own tools, although it was also reported that self-purchase was sometimes preferable anyway due to the poor quality and condition of equipment supplied on site (13). In describing factors affecting their purchase choice, most interviewees seemed to aim for a 'middle of the road' price (13, 51) and selection according to manufacturer (35).

> … Tools in the £15-40 price range are all pretty much the same …

Tool pricing was a concern for many, especially when the tools were vulnerable to theft, or had a short life-span (3, 61). In one case the tool performance (non-rusting) was referred to as a purchasing criterion (18).

Interviewees obtained their tools from a specialist supplier or through mail-order catalogues (18, 51). Some interviewees had received training in use and care of their tools, but rarely since initial or apprenticeship training (61). Others felt that they had just picked it up as they went along (20, 22, 35, 65) or relied solely on suppliers information (38). Instructions were sometimes considered unhelpful and left unread (2).

4.7.3 Equipment

Equipment, including machinery or plant brought onto site, was identified as directly involved and deficient in more than half of the accident studies. Failures relating to equipment included problems resulting from inadequate consideration of user anthropometry (body dimensions) or with the user interface. These were also shortcomings in performance, safety-related features and maintenance.

Inappropriate physical dimensions of some equipment resulted in user interaction, such as physical or visual access, being hampered. In accident 6, for example, a jump was required to climb off a scissor lift. Inspection of the equipment revealed that there were no distinct handholds on this equipment to support the user in this action, Figure 7.

> … We're taught to come down the scissor lift steps backwards, but the last step is about 2ft from the ground, so you have to jump the last bit …



Figure 7 Poor foot and handhold provision on scissor lift (6)

The safety cage on top of the scissor lift offered the most convenient points to grasp (at 2.2m from the ground), yet fixing bolts here were left exposed, compromising the only handhold available. A related problem existed in accident 21, in connection with the length of ladder attached to the side of a rail wagon (Figure 8). Elsewhere, use of split or cut down ladders was reported (25).

In a similar context, problems were identified with the use of scaffold towers. In some instances difficulties may be experienced in achieving a desirable scaffold and handrail height for the work requirements, given the fixed height scaffold components available (36, 62).

Another example, commented upon spontaneously by interviewees in a number of accident studies (but only immediately relevant for accident 50), concerned the small size of access opening between different scaffolding levels. This access space is frequently too small for larger individuals, or those carrying items about their person.

Problems had also arisen with operations involving manual movement of loads (22, 38, 60). In one case, load instability existed due to free movement of fuel within a bowser (38). In accident

22, problems occurred manoeuvring a laden plasterboard trolley (Figure 9). The trolley had directional wheels at one end only (the other end having fixed forward facing wheels). While it was not known which end of the trolley was leading, difficulties were to be expected moving a full load with this particular trolley design.



Figure 8 Ladder access to rail wagon (21)



Figure 9 Plasterboard trolley (22)

Equipment maintenance deficiencies featured in several accidents, especially with respect to steel parts (such as scaffold clips, concrete pipe clams and extendable steel props) (8, 18 and 4 respectively). Weathering and concrete were reported as the main antagonists. Although 'regular cleaning and maintenance programmes' were in place, overcoming rust and similar problems added to the physical effort required to use equipment. Failure to detect equipment damage contributed to some accidents. In accident 47, for example, an operative maintaining a crawler-mounted crane, fell from the running boards as the handle from the maintenance hatch

gave way. In another accident (94), a fire was caused by an electrical fault on a pneumatic breaker, which the supervisor thought had been caused by misuse of the equipment, but this damage had not been obvious to the operatives involved.

Examples were found where the design of equipment gave little heed to its usability or how the user might detect and monitor different states. Lack of status feedback (eg visual, auditory or tactile information to the user) was a factor in several accidents (4, 19, 38). Usability issues were reported in accident 11, involving the overturning of a delivery lorry. In this case, the interviewee described the wide range of lorry types he used in his work. There were common features however, such as the crane controls, but it was apparent that their design contravened user expectations (pushing the lever down raised the crane and vice versa). It was also reported that safety protection features built into the equipment did not anticipate this particular accident event.

Suitability of equipment was an issue in a number of accidents, where machines were being used for activities other than their primary purpose, eg excavator and forklift used instead of a crane (29, 74, 85).

4.7.4 Personal Protective Equipment (PPE)

Use of a safety helmet, high visibility vest and safety boots was mandatory on all sites visited, with supplementary use of protective eyewear, gloves, harnesses and respiratory protective equipment (RPE) expected depending on the work. Adverse comments were made about PPE in a large number of the accident studies. Criticisms related to poor fit and comfort; inappropriateness for actual task requirements; poor quality, care or condition; problems with availability and excess cost.

Comments concerning 'hard hats' focused on their frequent poor fit and comfort (5, 20, 24, 52, 63, 64, 82). Remarks were made about the lack of lining or padding, insecurity (due to lack of a chinstrap), poor ventilation (especially in summer) and being too small. Interviewees reported that hard hats were regularly dislodged or fell off (5, 63, 82), induced headaches (24) and interfered with work on looking up (23, 24). In accidents 27 and 82, for example, the injured persons' hard hat fell off when they bent down, both then struck their head on something when they stood up.

Many interviewees accepted or were resigned to wearing a safety helmet, regarding them as a necessary evil and, in a number of the accidents, helmets helped to reduce the extent of the injury (72, 91). However, it was also said that they are not always needed, with some frustration at the lack of flexibility over when helmets must be worn (22, 52, 64).

> … With the hat you're more likely to hit your head, as you don't account for the extra height when walking underneath different structures …

In many of the accidents where the hands were at risk, the injured person was not wearing protective gloves (52, 66, 80, 83, 95). There were complaints about the comfort and fit of gloves (1, 5, 33), with operatives not wearing them as they interfere with their ability to operate tools and the speed with which they can undertake their work (52, 95). Operatives reported inadequate supplies of gloves (necessitating use of worn out protection), poor durability and lack of a suitable size range (17, 18, 40, 52, 62). There were also reports that gloves are frequently mislaid with constant taking off and putting on (61, 62). In some cases the gloves worn were inadequate to provide protection from the risk (84, 86).

Fall arrest harnesses were discussed in a small number of accident studies (only specified trades require use of this PPE), yet among those who were in a position to comment, there was a

consensus of criticism about the equipment (4, 6, 17, 18, 36, 79). These included complaints about comfort and fit (especially when used for longer than 30 minutes), concerns about restriction of mobility and inadequate supplies (leading to harness hoarding among site operatives). Interviewees were also worried that the 2-metre lanyard length was inadequate or that they would experience physical injury from the harness itself should they experience a fall. As with other PPE, it was acknowledged that harness use was necessary, but interviewees felt that they should be permitted greater discretion over when to wear fall arrest equipment.

With regard to other PPE, protective eyewear was said to steam up and cause difficulties when performing certain tasks and under particular lighting conditions (20, 34, 35, 49, 63, 73). There were problems with protective eye-wear for those needing to use prescription spectacles (45), although suitable prescription safety glasses are available. Respiratory protective equipment (RPE) users mentioned problems with fatigue and being impeded when undertaking certain operations. There were some complaints about high-visibility vests, concerning the obstruction they pose when trying to access tools from waist belts (4, 8, 9) and a lack of fabric breathability, causing discomfort in hot weather (4, 8, 9).

Many interviewees reported having to buy their own protective footwear and in one case another reported purchasing his own protective eyewear. Interviewees reported receiving little instruction as to the maintenance of their PPE (18, 20, 24, 25, 34, 52), although when asked about this respondents thought that care was 'down to the individual', or instruction unnecessary as they had used it for a long time.

Interviews with supervisor/managers indicated that PPE and its availability were viewed differently than by those in operative grades. These respondents were concerned about the lack of care given to PPE, with reports of finding new and expensive PPE treated badly, left lying around or improperly looked after (36). Ordering and choice of PPE was in a number of instances undertaken by 'Head Office' (61) although in other cases supervisors/managers were involved. Only a few had tried ordering new styles, prompted by recommendation, observation of use by other construction teams, or through information provided in supply catalogues (40, 50, 51, 62, 63). One interviewee reported working with glove manufacturers to trial new products and another, in the case of a new short peaked hat, had tried it themselves to assess the product.

4.7.5 Materials and equipment supply

Interviewees reported the adverse effects of managing with insufficient quantities or having to work with incorrect materials or equipment. In some instances this was because of cost restrictions (4, 17, 38, 62). Supply inadequacies included missing, late or incorrect deliveries and also the delivery of materials where pre-fabrication had been expected but had not been fulfilled (22, 36, 40). Interviewees reported trying to reorganise work to accommodate this, but inevitably time was lost (40). In another case, it was felt that there had been a considerable increase in manual handling due to inadequate craneage time allowances. This was managed informally with cash payment for assistance from other contractors on site.

4.8 ORIGINATING INFLUENCES

This section reports findings from the accident studies concerning possible underlying or root causes of the accidents, here called 'originating influences' to emphasise their foundational role.

4.8.1 Permanent works design

Design of permanent works are an important influence on presence of hazards and exposure to risk on site. An analysis of design factors in the 100 accidents suggests that approximately half

of these incidents could have been prevented by a design alteration. This is discussed further in section 4.9.1.

Design revisions

Design revisions as construction progresses can lead to scheduling problems and project delays (9, 25). Changes may occur due to clarification of client requirements or as a result of architects being consulted over detail. Sometimes, original designs include incompatibilities between different construction elements. It was indicated that problems can be made worse where there is disagreement between those responsible for design choices.

> … We've had over a thousand architect instructions on this site because of disagreements within the outside design team. A good design should normally have no more than 300. The changes were for a range of reasons …. the area was not properly designed in the first place. The design didn't work or they had changed their mind from the original specification ….

This has implications for project management, including scheduling of resources, such as material supplies, labour provision and sub-contractor service providers.

The need to accommodate late requests from clients to develop or revise their work appeared relatively common from the architect interviewees. Such requests induced intermittent and considerable time pressure. The architects indicated that avoidance of architect instructions was preferable for project success. Their perspective, however, was that requests often originate from contractors, who use this method to increase time and financial allowances. However, information from senior site manager interviewees contradicted this, with the view expressed that extension claims and design revisions derive from client requests almost all of the time. In reality, the position is likely to be somewhere in the middle between these two positions.

Fine detail

It was apparent from the interviews that designers assume fine detail or specification of technical solutions to be the remit of the principle contractor or, more likely, located within the sub-contractor chain. Designers are wary of providing excessively prescriptive instructions as building tolerances are too great and greater precision incurs additional time and cost. From the site perspective, however, the perception was of having to perpetually seek clarification from architects because of inadequate or anomalous information.

Design ownership, from the site perspective, appears to have become blurred with the increasing prevalence of substantive sub-contractors. From the sub-contractor viewpoint, design ownership was seen as the domain of whoever had appointed them to undertake the work (5). Sub-contractors develop and undertake the portion of work that they have been contracted to fulfil, yet at times have little knowledge about the context of this or the interaction with other service providers. In accident 3, for example, which involved an extractor fan catching fire, the fan manufacturers were not involved in ducting and fire protection modifications. Responsibility for these aspects was taken by the employing contractor.

Utility information

Provision of incorrect drawings or information regarding utility services (such as underground supplies) featured in some accidents, resulting in the need for further liaison and revision later in the build process (9, 20, 52).

Innovation

Follow-up interviews with architects suggested there to be a small number of lead architects pioneering new practice or innovation. Clients might encourage such developments for high profile landmark projects, with elements then finding their way into standard building practice

over time. It would appear, however, that innovation tends to be motivated by considerations such as building aesthetics and functionality, or construction efficiency and cost, with any safety benefits being incidental.

4.8.2 Project management

Contractor arrangements

Sub-contracting was a feature on all sites visited, with sites often retaining a list of tried and tested sub-contractors invited to tender for work. A number of interviewees described themselves as self-employed, or as self-employed but linked to a sub-contractor employer (9, 11, 65).

Given the fluctuating skill and labour requirements on a construction project, the prevailing view is that use of sub-contractors increases flexibility and reduces costs over retaining permanent employees on full pay. Some interviewees, however, expressed opinions regretting the loss of a directly employed workforce (1, 4, 21). These emanated from interviews with principal contractor employees and related to problems with the performance and supervision of sub-contractors on site (4, 10), and a lack of initiative and decrease in 'reaction time' when something needs to be done (1, 10, 25).

> … The sub-contractors are working in isolation; they just consider themselves rather than the rest of the site …

Responses from sub-contractor interviewees provided a different perspective on these issues. While there were similar reports of working in 'isolation' from sub-contractors, this was said to be in the context of lack of consultation and communication by the principal contractor (5, 38, 62, 64). Examples given were the failure of a principal contractor to hold daily meetings with sub-contractor supervisors and increasing displacement of formal communication channels the longer the time spent on site (5). Where liaison did occur, it was reported that this was often without the inclusion of principal contractor workers or other teams on site, and that it was purely 'task' orientated (38, 62).

> … It's frustrating managing practical matters with the principal contractor. You get left to your own devices and the managers wash their hands of you …

The consequences of these problems manifest themselves in confusion over ownership of responsibilities, especially (although not exclusively) in construction management (10, 50, 62, 64); complaints that sub-contractors do not project manage or address safety issues adequately (10, 25); and problems with communication and accountability within lengthy sub-contractor chains (34). In accident 51, for example, it was identified that liaison through a chain of four different sub-contractors was required in order to arrange for a work area to be cleared so that other work could start.

Another aspect to contractor arrangements mentioned is that principal contractors may hand over responsibility for work organisation to sub-contractor supervisors (52), yet continue to instruct their operatives, confusing arrangements for overseeing their work (61). On another point, interviewees reported poor liaison between principal and sub-contractors when procuring materials, supplies or PPE (1, 61, 62, 64).

Labour supply

Many supervisor/manager interviewees reported problems with labour supply, with respect to both volume and quality of workers. It was remarked that selection sometimes depends on who is available rather than being able to pick and choose (3, 12, 20, 22, 23, 37, 62). Poor

availability of labour appeared especially acute in the larger cities. Interviewees also reported that they are sometimes required to appoint a designated quota of labour from the 'local' population. At times they felt that this resulted in individuals undertaking tasks for which they were insufficiently qualified or experienced (3, 37). A contact list of reliable workers was often compiled to help overcome these problems.

Responding to absenteeism was also indicated to be a problem, sometimes resulting in tradesmen and operatives being asked to take on work outside their normal area of expertise (20, 22, 23, 38, 39). There were complaints that multi-skilled 'modern day' apprentices are lacking in work experience and are at times 'more of a hindrance than a help' (63).

Work scheduling and time pressure

Time pressure within site schedules was often reported (1, 2, 3, 9, 53), with concerns about financial penalties from project overruns a preoccupation for managers (25, 61).

Follow-up interviews suggested that build scheduling and planning of the project timeline appear to be largely based on previous experience. This needs to make allowance for elements such as time to go through the sub-contractor tender and appointment process; time lost due to inclement weather; time for closure and holidays; time to accommodate quiet periods (in residential areas); and time for materials such as plaster and concrete to cure. There was no mention of any allowance being made to accommodate injury or sickness absence, however.

Computerised packages (such as 'SPODS' or 'ADEPT') reportedly offer advantages with project planning, although it is not known how widely these are used or whether the perceived benefits materialise in practice. Benefits from project management software were said to include being able to provide a client with cost estimates and management of workload where late or missing information is a factor. Where no such tools were available, planning appears vulnerable to the nature of relations with the client; where these deteriorate, this in itself can carry a significant workload overhead.

A tight build schedule leads to an increased workload, with weekend, late evening or night work sometimes necessary to accommodate this (21, 61). Extended working hours may have implications for alertness and reliable decision making.

Interviewees described a variety of influences that affect the pace of their work, such as delays caused by a need to check site conditions prior to proceeding with a task (60) or pressure arising from the limited handling life of materials, or a need to avoid obstructing other activities (8).

> … I had to be quick because the concrete was setting and because the lorry was blocking the road outside for the delivery …

Other circumstances described as leading to time pressure included a need to complete work and vacate an area to give access to another trade; making materials and equipment available for others awaiting them (2, 4, 12, 19); problems arising from shortages or late deliveries of materials or equipment (9, 62); having to clear up or circumvent debris or the unfinished work of others (18, 25, 50); and slowness induced by another labourer or trainee (18). Time pressure from being 'rained off' was also reported (9).

A competitive element causing time pressure was sometimes apparent. In some instances this occurred due to individuals undertaking priced work and needing to get as much done as possible (5, 13, 61, 63). In other cases there was more of a leadership influence, with reports of competition between different work teams or because of the approach of particular site manager or sub-contractor foremen (1, 5, 50, 63).

> … The charge hand wants a surge of work first thing in the morning. The work's not behind, its just his character …

In some situations where a faster work pace had been required, it was thought that safe working practice would be maintained because of the supervisors' request for it and by virtue of their presence (62, 64).

4.8.3 Construction processes

Method statements

The manner in which it is envisaged site construction should proceed is documented in method statements, usually prepared as a project management function, off-site. The content of these varies from a rudimentary process description of the construction stages, through to much more detailed instructions as to how the construction should be undertaken. Invariably, however, site supervisors and trade workers are left to draw on their expertise and experience when it comes to common tasks, with the method statements remaining unread in the site office (73, 80, 82, 92, 93).

Job titles of those responsible for the preparation of method statements encountered in this research included contracts manager (1, 9, 13, 50), project/construction manager (2, 5, 9), facilities manager (3), civil engineer (4), or site/general manager (9, 11). Often, new method statements were developed from existing statements or generic materials, sometimes converted to a style used by the site principal contractors. Interviewees on site were occasionally consulted or involved in preparation of the method statements, although this appeared unlikely for operative grades (1, 22, 40) or sub-sub-contractors in the chain. Those interviewees that were able to comment on the method statement development process indicated that the documents were often prepared before site work began (22, 50), commonly with inadequate information available (9, 22) or under time constraints because the statements were prepared as part of the bidding process for a contract (33).

Method statements varied in length. In some cases they were just a single sheet (38, 40), but in others the statement was up to 20 pages, with multiple process steps (forty four in one case) (39). Asking operatives to read a method statement, or a supervisor reading it out to them, was sometimes used as a training medium. Frequently, however, the language and presentation style of the method statement was complex and would be inappropriate for those with poor literacy skills (1, 33, 39).

In any event, there were no applicable method statements for the activities being undertaken in many of our accident studies (6, 7, 8, 9, 17, 18, 19, 20, 21, 23, 33, 34, 36, 37, 38, 50, 51, 61, 62, 66, 67, 68, 70, 72, 73, 75, 76, 81, 82, 83, 85, 86, 88, 89, 95, 96, 97, 100). Sometimes this was because the work in progress at the time of the accident was a generic operation, below the level of detail in the project method statements. In accidents 10 and 51, for example, there was no specification for boarding (both quality and dimensions) to cover holes in the ground. Responsibility for such temporary works design appears unclear, with decisions taken regarding performance aspects such as board diameter/density/loading capacities probably left to the carpenter.

> … There is no culture of calculating ply requirements; the technical ability is not on site …

In other cases, the absence of a method statement was because the accidents occurred while workers were not engaged in a defined construction operation, for example they were moving around the site or carrying out preparatory work. Where method statements did exist, many

operative interviewees were unaware of them and were not able to recall any procedures or instructions for their work (11, 12, 22, 33, 34, 35, 52, 60, 63).

4.8.4 Safety culture

Generally, comments across the range of interviewees about site safety culture were positive, pointing to the greater emphasis on safety in the preceding five years or so. Nonetheless, there were some adverse remarks to the effect that safe practice is overridden by production pressures (25, 37) and that, despite what is said in induction, 'safety' is more for appearances sake than actual implementation (11, 60). Where interviewees provided positive feedback on safety culture, this was at times judged in the context of a safety failure (7, 63).

> … I couldn't fault them – they took me to hospital when the accident happened …

Responsibility for safety

Supervisory/manager interviewees were asked about their responsibilities for health and safety, and any training and review of performance in this respect which they had received. Only one interviewee indicated that a responsibility for safety was clearly defined within his contract of employment (63), with the position in the case of others less robust. Some interviewees reported that health and safety responsibilities were part of their role, although not specified (23, 40). One interviewee had received an instructional folder from his safety advisor (61). Others felt that various site documentation (eg site rules, codes of practice, scaffold register, method statements or risk assessments) defined their responsibilities (25, 33, 36, 37, 38, 50, 52, 60, 62, 65). In terms of safety management performance monitoring, some interviewees reported 'none' (38, 50, 52), while others highlighted regular liaison with their safety advisors (61), reactive monitoring according to accident occurrences (17, 25, 62), or audit by the principal contractor (65).

Training among these interviewees in safety related matters varied, with many unable to provide spontaneously details of training history and duration at the time of interview. Although details were unavailable, the impression was that a majority had received some health and safety training in the preceding five years, although a sizable minority had received none. For those that had undertaken some training, the duration was in most cases between one and six days. Some respondents viewed 'First Aid at Work' certification as health and safety training.

Notwithstanding the above, an impression gained from the accident studies was that there is widespread disinclination among operatives, supervisors and site managers to take responsibility for safety. Some respondents placed the obligation for taking action on safety issues squarely with the visiting safety adviser (51).

This sometimes manifests itself in a failure to appraise alternative methods of working or in not putting new ideas into practice (17, 22, 35). In accident 35, for example, an eye injury was caused by metal swarf during a drilling operation. The drilling was being undertaken in preparation for use of pop rivets to join metal ducting. During the interviews it emerged that self-drilling screws could have been used as an alternative to pop riveting in this situation. As well as possible safety benefits through eliminating the need for pre-drilling, there should be time saving through using screws. Although negative comments were made by others about equipment cost and screw-gun safety, it was not apparent that there was any process or encouragement at site level to weigh up the pros and cons of different ways of performing such tasks.

It was also observed by the researchers that there seems to be an acceptance or 'blindness' to longstanding safety problems. In accident 18, for example, protruding nails remaining as a

consequence of removing shuttering were unquestioned by site, office and training staff, yet potential for injury from these was significant.

At the level of the organisation, there were suggestions from sub-contractor interviewees of a lack of responsibility and action from the big companies (64). In accident 50, for example, the sub-contractor group felt that erection of safety barriers, rather than a board over a hole in the ground, would have been a more appropriate safety precaution. Unfortunately, the sub-contractors felt that a decision such as this was not within their remit on site. Conversely, a principal contractor viewpoint was that sub-contractor groups had inadequate insight into how safety management should be implemented in practice (2).

> … If it's a cut it's our fault and he gets a pair of gloves, if it's a trip it's not our fault as others supply the workplace …

Safety personnel

Interviewees having a safety role had a variety of backgrounds and training, ranging from trade to professional positions. When referring to this position, 'safety officer' was the term most commonly used by site personnel, although the job holders themselves used the term 'advisor' or 'manager' in preference. For those that were not called 'manager', there was some concern about reduced credibility (10). Safety personnel interviewees had received a wide range of training, varying from short courses of less than one week (eg Safety for Supervisors training), through to NEBOSH Construction & Certificate training, NEBOSH Diploma or courses at degree level.

The safety role often appeared to be seen as one of enforcement or policing by those on site (1, 9).

> … We were trying to get away without a handrail on the scaffold to save some time. We thought it was safe and were happy with it, but the main contractor saw us and told us off. We just had to put our hands up to it and say we'd done it …

Most safety advisors seemed to think that they provided a valuable and worthwhile contribution. Some, however, indicated that their appointment was a second-choice option, away from a professional site position (eg Engineer) and something to which they were directed by their employer rather than choosing it for themselves (5, 9). It was obvious in some instances that the safety advisor role and its incumbent were not viewed with a great deal of respect (10).

Risk management

The analysis presented in Table 15 identifies a failure in risk management in most of the 100 accidents studied. Given the legal obligation for risk assessment under the Management of Health and Safety at Work Regulations (HSC, 2000) and the requirement that a written record should be kept of the significant findings, it is noteworthy that there was no risk assessment available for many of the situations in the accident studies (6, 7, 8, 9, 17, 19, 18, 20, 21, 23, 24, 36, 37, 38, 40, 50, 54, 65, 66, 67, 68, 70, 72, 73, 75, 76, 81, 82, 83, 85, 86, 88, 89, 95, 96, 97, 100). Most often this was because the accident activity was seen as a core skill of the person undertaking the task (1, 2, 33, 61) or because the accident did not occur during a task activity.

Where risk assessments did exist, the hazards that contributed to the accident events were often excluded (2, 12, 34, 39, 52, 61), or control measures had not been enforced (35). It was generally the case that operatives, and sometimes their supervisors, were unaware of the existence of the risk assessment (12, 22, 33, 34, 35, 52, 60, 61, 63).

In practice, risk assessments were commonly integrated into an accompanying method statement. While the work steps were often carefully structured, these were generally in terms of the construction process rather than the tasks actually needing to be performed by workers (1, 2, 5, 24, 35, 39, 40, 63). In accident 5, for example, the work sequence and lifting equipment required to move the 140kg steel angles into the building were recorded, yet there was no description of the steps required to load or unload the angles between the different handling equipment.

It is of course possible that the manual lift in accident 5 was an unplanned activity, highlighting a further area of concern. Method statements are usually prepared well in advance of the time at which the operation is performed, and/or are generic documents for repeated application to same type situations (9, 10). In either case the content describes a best case scenario, isolated from the circumstances prevailing at the time of execution, such as access to an area, or the availability of equipment and tools. As such these documents may be useful for planning the build process, but are ineffectual in identifying and controlling risks. Nonetheless, the documents are sometimes used as an audit tool to confirm safe working methods (11, 22).

Accident investigation

Effective accident investigation is a valuable means of learning from failure. The thoroughness of accident investigation was examined where possible by comparing actual site accident reports with the descriptions of events provided by interviewees for the research. It was often the case that accident reports gave only brief details of incidents. At times, accident-involved interviewees were unfamiliar with the recorded description or their own account of events differed in material respects from that documented (13, 37). In some instances, accident reports were being used as a forum to document complaints or requests for improvement to work circumstances (62).

> … Slipped on inside of scaffold, fell and twisted left knee. Mud on boots caused slip. Designated footpath was asked for in H&S meeting. Item 15 in minutes …

Although attribution of causes of accidents included some that were viewed as chance events (9, 33, 36), many identified failings on the part of involved-persons, such as over-familiarity (2), carelessness (19, 24), complacency (22), negligence (24), rushing (24), lack of concentration and judgement (2, 11, 22, 24), or distraction (13, 22, 33, 37). There seemed to be little appreciation that these are everyday human failings that ought to be anticipated in an effective safety management process.

Identification of accident remedial action

In the case of many accidents, there had been no remedial action after the event. Different reasons were given for an absence of response, including the accident being caused by accepted hazards and being a routine part of the job (9, 33, 34, 50, 97); the activity being a one-off or involving temporary work (36, 60, 61), and that any action would have taken longer to carry out than the job itself (61). Interviewees also reported that remedial measures were considered unnecessary because they were already following site rules (4, 22, 36), or because action was outside their remit and the responsibility of the principal contractor (22, 51, 64).

Where measures were taken these fell into several categories of response. A frequent approach was to review and reinforce guidance on work behaviour, such as advising people to get extra help when needed (39, 50), or to use less hazardous techniques (19, 23, 24). In other cases, the response was to remind workers of the need to use PPE (33, 39, 63, 65, 92), to recommend improved housekeeping in the work area (25, 53, 62), or to install traffic cones over walkway obstructions (64).

In a small number of instances, the remedial action might have been expected to have more enduring consequences, either through the development and instigation of more robust procedures (20), or the consideration of safer equipment designs (12, 38).

Consultation and participation

Operative grade interviewees reported differing experiences of consultation. Some stated that they are simply 'told' what to do and are not part of any consultation at all (10, 12, 22, 50, 52, 60, 61). Other interviewees were included in discussions about work organisation, but not about safety (20, 25, 52, 63) or vice versa (24, 37, 61). Although most interviewees felt that they could initiate discussions or make suggestions if they wanted to, there was mention of inaction in response to concerns raised about inadequacies in the provision of facilities (2) and the quality and safety of materials and equipment (1, 4, 25).

Interviewees often had useful ideas or experiences from previous work (often abroad) giving possible solutions to problems with tooling, equipment or materials design (1, 9, 18, 52).

> … The tying wire comes in a 25kg roll here, but in Germany they come in small cartons which is much better …

> … When I was working in the Bahamas they used to have proper nips for cutting steel banding, but I haven't seen them here …

> … The sun bounces off the concrete and causes a lot of glare – perhaps adding some colour to the mix would reduce this? …

Disappointingly, none of these ideas had been communicated to anyone in a position to evaluate and implement them. Neither did there seem to be any mechanisms in place to encourage this.

4.9 DESIGN POTENTIAL TO REDUCE RISK

Additional analysis of the accident study data was undertaken to examine the possible contribution of design in each incident (analysis presented in detail in Appendix E – Design Prevention Analysis). This was undertaken from the viewpoint of what could designers have done to reduce the risk? Consideration has been given to both the options available to the designers and whether choosing an option would actually have reduced the risk. Although such an analysis depends on subjective judgement, it does give a useful indication of the potential for design to improve safety.

Alternative design options were placed in three categories by the analysis:

- unlikely to have reduced risk
- may have reduced risk
- likely to have reduced risk

Four types of designer have been considered:

- permanent works designers (architects / civil & structural engineers / mechanical & electrical engineers etc)
- materials designers (design of materials themselves and their packaging, delivery method etc)
- temporary works designers (scaffolding / formwork / falsework etc)
- equipment designers (tools, plant and equipment)

The design of the workplace, work task etc are also important considerations in accident causality. However, these have not been included in this analysis as the construction sector does not typically regard these as 'design'.

4.9.1 Permanent works designers

Permanent works designers could have reduced the risk in almost half of the accidents (25 likely / 22 maybe – Figure 10). One of the main decisions that permanent works designers could have taken to reduce the risk was to reduce the amount of work done on site, mainly through increased use of some form of pre-assembly.

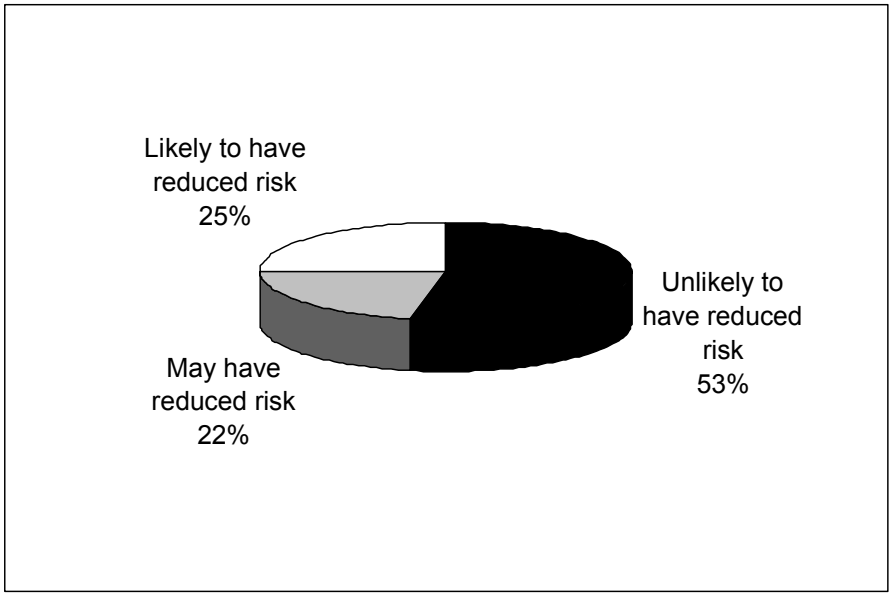


Figure 10 Permanent Works designers opportunity to reduce risk

4.9.2 Materials designers

Materials design may also involve the permanent works designers, but is often a separate operation, with the permanent works designers choosing from the options offered by materials suppliers. Over time, permanent works designers and other specifiers in the project team can influence the materials designers by continually asking for certain materials, or by ceasing to specify others. However, there does not appear to be much opportunity for effective communication and feedback between permanent works and materials designers. The design of the materials themselves and also of the packaging and delivery method have been included in this category.

Materials designers could have reduced the risk of more than a third of the accidents (17 likely / 18 maybe – Figure 11).

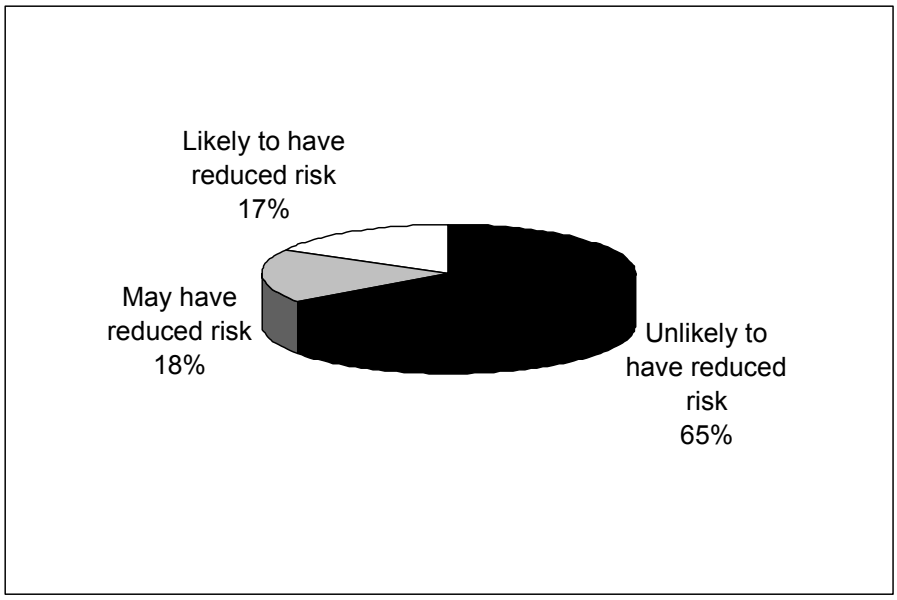


Figure 11 Materials designers opportunity to reduce risk

4.9.3 Temporary works designers

Temporary works traditionally include scaffolding, formwork, falsework and support structures for excavations etc. Temporary works designers are often employed by the principal contractor or sub-contractor rather than the permanent works design organisation. Designs are, however, often checked by the permanent works design engineer. The temporary works designers could have reduced the risk of more than a third of the accidents (26 likely / 10 maybe – Figure 12).

4.9.4 Equipment designers

This research has found that there appears to be little feedback or communication between the designers of tools, plant and equipment and others involved in the construction process. Many of the accidents studied involved tools or equipment, with personal protective equipment included in this category.

It was judged that equipment designers could have reduced the risk in 60 of the 100 accidents (35 likely / 25 maybe – Figure 13) through improved design of the equipment being used. In some cases, the equipment involved did not appear to be the 'best available' and therefore a straightforward approach to initial risk reduction would have been selection of the best equipment for the task.

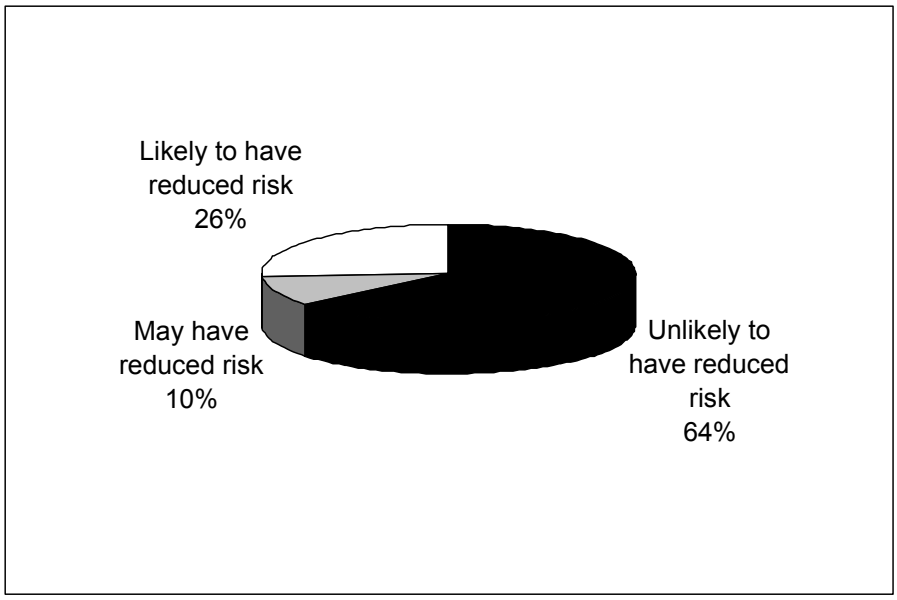


Figure 12 Temporary works designers opportunity to reduce risk

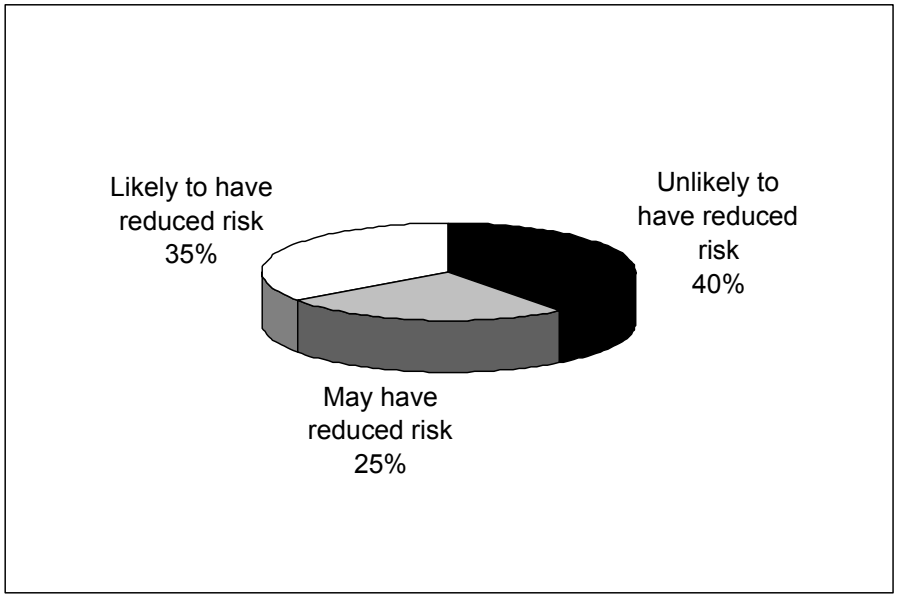


Figure 13 Equipment designers opportunity to reduce risk

5 UMIST MODEL AND ACCIDENT CAUSES

5.1 BACKGROUND TO MODEL

One of the intentions of this project was to apply a model of causal factors developed by Suraji and Duff (Suraji et al, 2001) to investigate the relationship of distal factors postulated by the model. There were two objectives to this:

1. To test the applicability and usefulness of the model.
2. To make use of the model in guiding the investigation of possible distal factors in the accidents studied.

The model describes the constraints and responses experienced by all the parties involved in project conception, project management, design, construction management and construction, which may impact on accident causation, and the interactions between the parties that provides the mechanism, or 'domino effect', of these sequences of constraint and response (Figure 14). These constraints and responses of participants 'upstream' of the construction process are distal (sometimes called latent) factors that contrast with the proximal factors that occur in the immediate environment of the construction process in which the accident took place and led directly to the accident.

The analysis here has been confined to the thirty accidents for which the most detailed data on distal factors were available. Appendix F presents a brief summary of the causes identified for each of these accidents, followed by a short list of key words, often related to the Constraint-Response Model. It should be noted that the distal causes identified in this way are, in the main, hypothetical and, in the great majority of cases, the most that can be said is that they may have increased the risk of the accident happening. This is the very nature of the Constraint-Response Model, or indeed any type of latent factor model: a different response by the participant experiencing the constraint might very possibly have avoided the accident but may, in doing so, have introduced alternative risks to construction personnel.

The analysis has been limited to the immediate constraints and responses identified, with no attempt to study the situation further upstream. For example, a failure by a designer to use, or even consider, an alternative form of construction, thus providing a constraint to the construction process, may have occurred for a variety of reasons, eg time or cost constraints imposed by the client; lack of understanding of the construction process and construction risks etc. Detail necessary to explore these issues was not available to the research.

5.2 APPLICATION OF MODEL

Whilst a sample of 30 accidents is not large enough to be statistically representative, it is worthy of note that the causal types that dominate were Inappropriate Construction Planning and Inappropriate Construction Operation, each occurring 19 times (63%) (Table 16). Inappropriate Operative Action also occurred frequently, on 11 occasions (37%). The results of the original research (Suraji et al, 2001), using data from the HSE Focus database, are also included in the table and, whilst demonstrating the same three major causal factors, provide a marked contrast in the relative frequency of Inappropriate Construction Planning.

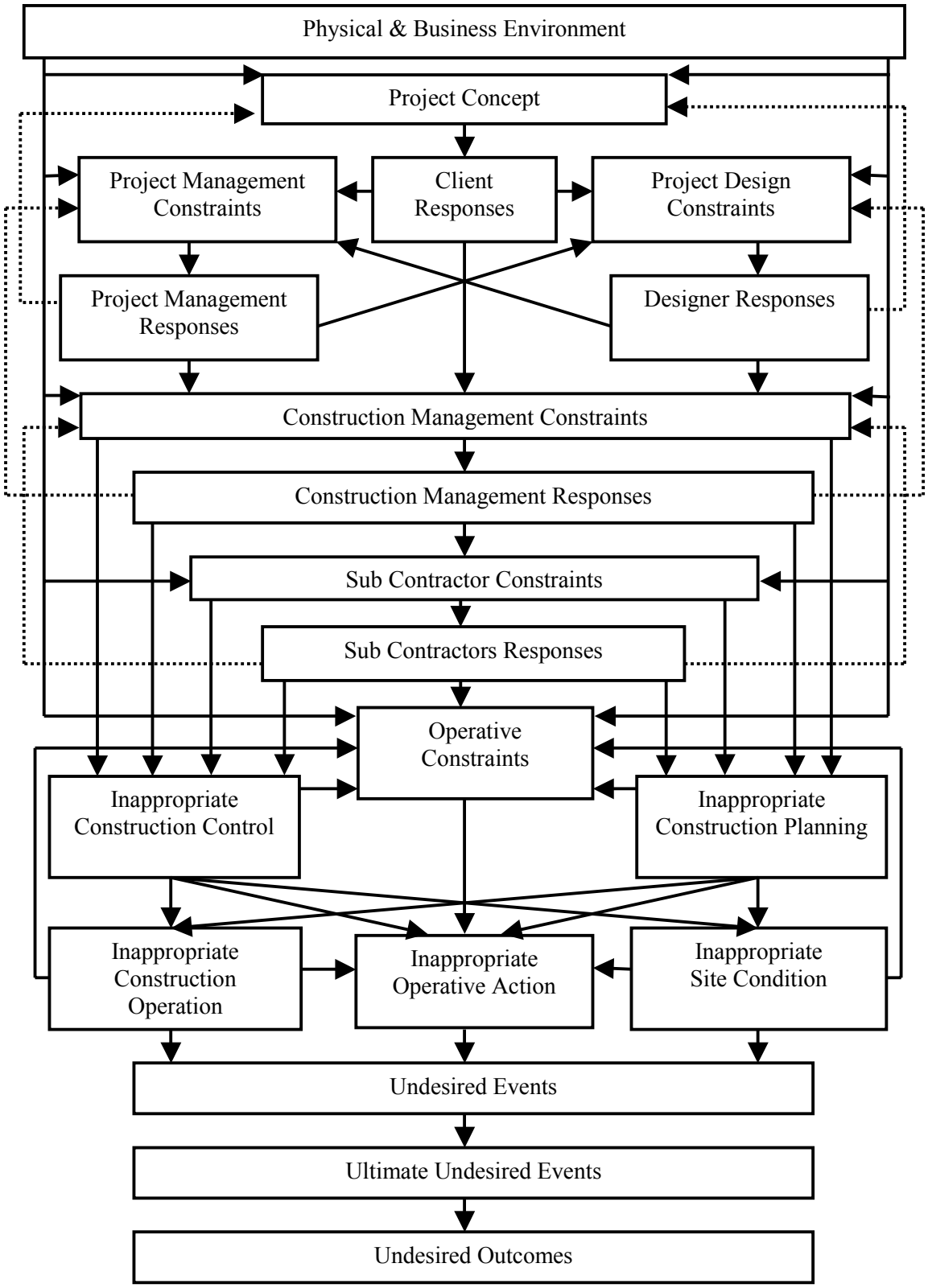


Figure 14 Constraint-response model of construction accident causation

There are several reasons that might explain this, relating to the origins and methods of collection of the data. The most credible of these is thought to be that the data collected in this research set out to embrace factors upstream of the immediate environment of the accident, whereas data from the HSE Focus database, provided by the investigating HSE Inspector, was predominantly concerned with safety failures in the activity being undertaken. This would also help explain the higher incidence of Inappropriate Construction Operation.

Table 16 Analysis of causal factor types

Type of causal factor	*Frequency (n=30)*	*%*	*% from previous research*
Inappropriate construction operation (ICO)	19	63	88
Inappropriate construction planning (ICP)	19	63	29
Inappropriate operative action (IOA)	11	37	30
Inappropriate construction control (ICC)	3	10	17
Inappropriate site condition (ISC)	3	10	6
Designer responses	3	10	n/a
ICO / ICP	12	40	n/a

The last row in Table 16 shows the incidence of Inappropriate Construction Operation (ICO) and Inappropriate Construction Planning (ICP) together. This accounts for almost two-thirds of the relative frequency of each factor on its own and suggests that the majority of instances of Inappropriate Construction Operation might have had their origin in Construction Planning, thus moving the responsibility for the operational failure into the pre-construction environment.

Considering the Constraint-Response areas of distal accident causation, there were only three (10%) instances of building or engineering designer implication (Designer Response), although there were many more instances where design of equipment or tools featured. To draw firm conclusions from this is difficult and has the potential to seriously mislead. This is because collection of data from designers on issues such as the scope for designing out the task that put the operative at risk proved very difficult. The culture of the design professions still seems to involve a denial of responsibility for careful analysis of the methods of construction implied by their designs, let alone investigation of alternatives to reduce construction risk. So exploration of these issues in the data collection became all but impossible.

The available data did not permit investigation of any other Constraint-Response routes through the model. For example, though there were instances of time pressure, a clear link with the accidents concerned and the origin of the time pressure, such as constraints imposed by client or project management, were not established. Statistical correlation, as undertaken for proximal factors in the original research (Suraji, 2001), which might suggest causal links, would require a much larger number of cases.

6 DISCUSSION

This research used a combination of focus groups and studies of 100 accidents to explore the complex interactions of factors that compromise safety in the construction industry. The focus groups collected opinions of industry stakeholders, while the accident studies sought to provide verification of the issues raised by the focus groups.

Similarly to previous work (HSE, 1978, 1988; Whittington et al, 1992), the investigation has documented the pattern of involvement of the immediate circumstances in accidents, such as unsafe actions by workers, poor communication, problems with site conditions, and shortcomings with equipment and materials. The project has gone further, however, in seeking to trace the wider influences determining the presence of these proximal deficiencies. This was prompted by the increasing recognition over the past decade concerning the extent and strength of design, management, training, and safety culture effects on construction safety (Whittington et al, 1992; Gyi et al, 1999; Brabazon et al, 2000; Bomel, 2001; Carpenter et al, 2001; Suraji et al, 2001).

6.1 STUDY LIMITATIONS

The 100 accidents examined for this research were a convenience sample. In several respects, the distribution of accident types and their circumstances may not be representative of the true pattern of accidents across the construction industry. Through necessity, the study focussed on less serious incidents. It was agreed with HSE at the outset of the research that it would be necessary to avoid accidents that were or might become subject to HSE investigation. This was to make sure that evidence would not be contaminated and to avoid the possibility of the researchers being drawn into any legal proceedings. Although the analysis discussed in section 4.3 demonstrates that the outcome of many of the accidents examined could have been much more serious, it should be borne in mind that there may be differences in the pattern of causation between serious and less serious incidents. Falls from height, for example, often result in multiple injuries. Coupled with this is that working at height involves distinct work activities and equipment. Through concentrating on less serious accidents, factors involved in accidents such as falls from height may not be fully represented in the present study findings.

This research depended significantly on the goodwill of construction organisations. This was firstly in their drawing accidents to the research team's attention, and then in allowing access to sites and personnel for interview. Efforts to interest smaller companies in the project had only partial success, the consequence of this being that most accidents available to the research came from larger sites, through the principal contractors. While Table 10 and Table 11 indicate that a good spread of accidents was achieved across construction sectors and accident categories, there are areas of construction underrepresented in the study. Although accidents to self-employed workers or those working for small sub-contractors were included, these were almost all within the context of the operations of a large principal contractor. The study has not encompassed the small builders, working in isolation, generally regarded as having an especially poor health and safety record.

A methodological difficulty encountered in examining off-site or upstream influences on the 100 accidents was that key individuals, such as the relevant designers, other head office personnel, and equipment or materials manufacturers/suppliers proved difficult to identify and then to arrange to interview. Where this was achieved, the interviews did not always reveal as much as might have been hoped for, due to defensiveness on the part of the interviewee or because they were surprised to be asked questions about an accident in which they did not perceive they had played any role. While this lack of acknowledgement of influence is an

interesting finding in its own right, it resulted in a decision being taken mid-way through the research to move to more accident-independent investigation of the wider influences on the accident cases. This entailed interviewing a range of individuals competent to comment on the issues that emerged from the accident studies. This approach still provided valuable insight into accident causation, although the direct linkages between cause and outcome within each incident become lost. Even where accident-dependent analysis had been possible, the nature of the off-site or upstream influences meant that suggestions of causation in individual accidents could usually only be speculative.

6.2 NATURE OF CONSTRUCTION ACCIDENTS

All accidents are multi-causal, with a rare combination of factors needing to coincide to give rise to an incident. Underlying each of the causal factors are a range of influences determining the extent to which they undermine safety. Operatives' actions, for example, are influenced by their attitudes towards safety, their knowledge and skills, and their alertness and health. These, in turn, are affected by peer pressure, education and training, working hours, payment schemes, previous injuries or ill-health, and so on. The existence of hazards on site is a consequence of influences such as planning and preparation, supervision, housekeeping, project management and safety culture. Considering materials and equipment, the suitability, usability, condition and ultimately safety of these are a result of their design, selection and then availability and supply.

Figure 15 summarises the influences identified by this research which operate to cause construction accidents. The diagram indicates that accidents arise due to a failure in the interaction between workers, their workplace, and the materials and equipment (including tools and PPE) that they use. This immediate failure is precipitated by various shaping factors, which may be grouped under the headings of worker factors, site factors or material/equipment factors. These shaping factors are a result of originating influences, such as the permanent works design, project management, construction processes, safety culture and risk management. Client requirements, the economic climate in which the construction takes place, and the construction education which all parties have received bear upon these. The application of these factors in actual accidents is illustrated in Vignettes 1-4.

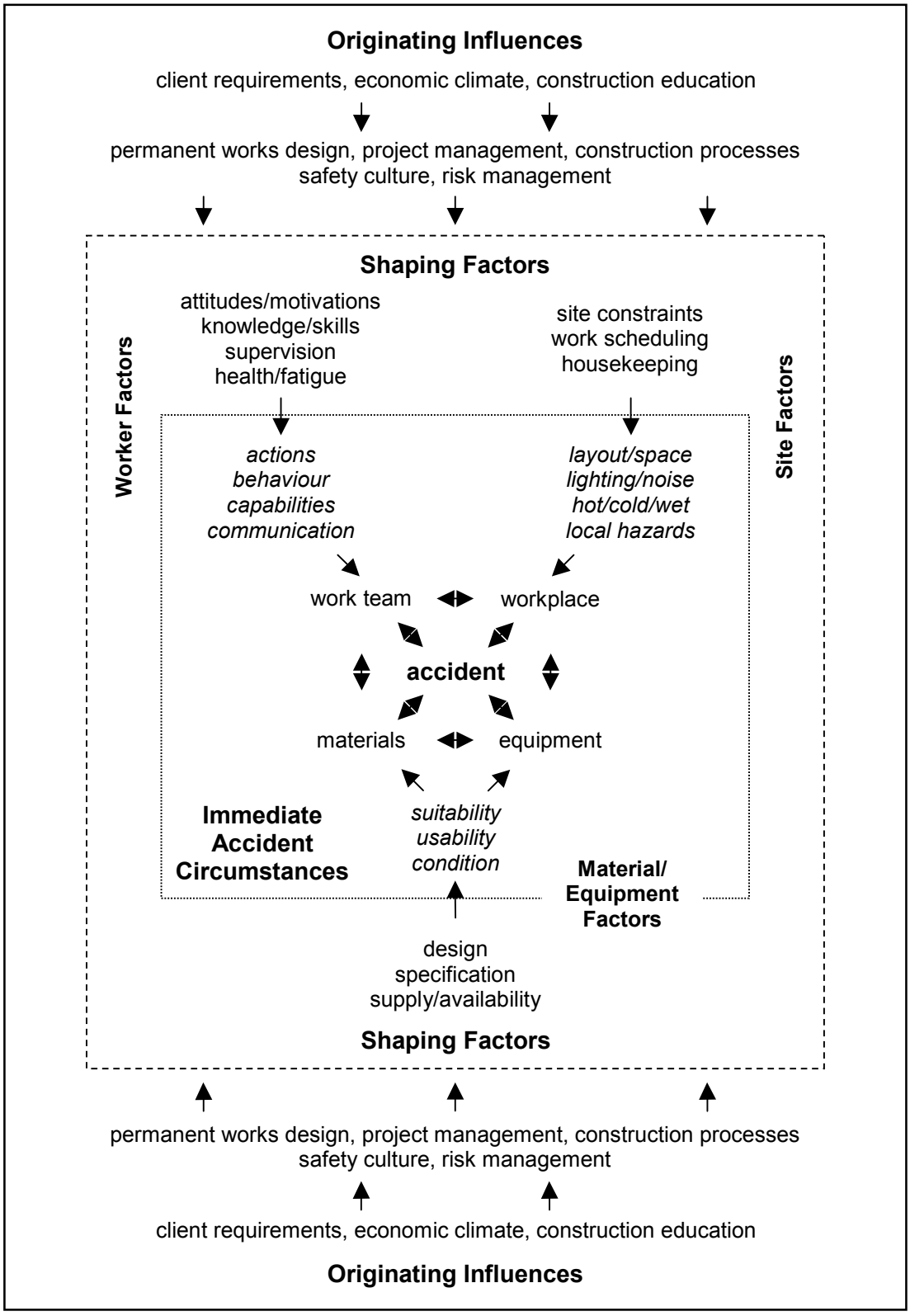


Figure 15 Hierarchy of influences in construction accidents

Vignette 1 – Accident 12

Accident background and information
An engineer's assistant, aged 18, injured groin and back, whilst directing the end of a concrete pump pipe into a waste hopper during 'blow-down' at the end of a Saturday shift. "Cleaning out concrete pump. Cleaning ball from concrete pump discharged rapidly and caused pipe to move suddenly"
(*quote from accident report*).

The key aspects of this accident map across the hierarchy of influences as follows:

- Immediate Accident Circumstances
- Shaping Factors
- Originating Influences

Work team (Immediate Accident Circumstance)
Actions and behaviours of IP and partner were mistaken. Neither had the skills or knowledge required and the supervision seems to have been lax. In particular, the IP was an engineer's assistant who is unlikely to have had the capabilities, nor any experience or training in manual handling in any of the tasks involved with the concrete pump operation. There was poor communication between operatives involved and with the supervisor who was positioned on another floor (where the concrete pour was taking place). The IP was unaware of the correct procedures. These factors suggest that the supervision, project management and construction processes were not effective.

As the work was being done on a 'job-and-finish' basis on a Saturday, there is a strong suggestion that the motivation was to finish quickly. All involved with the pour had limited access to work breaks which may have caused fatigue and contributed to the incident.

Workplace (Immediate Accident Circumstance)
There were restrictions in the working space in the task area.

Equipment (Immediate Accident Circumstance)
The suitability of the concrete pump equipment may have been a factor as the pipes and the hopper appeared to be unstable during the 'blow-down' procedure. The concrete pump manufacturers stated that the preferable method for 'blow-down' was to use water rather than compressed air although this was rarely done on site. There was little consideration of human interaction in the pump design and the designers had no knowledge of accidents involving their equipment.

The fitter/drivers of the concrete pumps were trained, and the pump supplier offers to stay on site during the first few hours to check that the operatives are competent. However, it is not clear whether this offer had been taken up on the day of this accident.

Risk Management (Originating Influences)
There was no risk assessment for the 'blow-down' task.

Vignette 2 – Accident 36

Accident background and information
A plumber, aged 34, fell, whilst working above a suspended ceiling connecting pipe work. "Whilst climbing down from a mobile aluminium scaffold the IP banged his left elbow on the aluminium strengthener around the access / egress hatch causing a fracture to the left elbow"
(*quote from accident report*).

The key aspects of this accident map across the hierarchy of influences as follows:

- Immediate Accident Circumstances
- Shaping Factors
- Originating Influences

Work team (Immediate Accident Circumstance)
Actions and behaviours of the IP mainly relate to his unfamiliarity with harness use resulting from a lack of knowledge and skill. The supervisor was unsure of what the IP was doing.

Workplace (Immediate Accident Circumstance)
Access for works above suspending services is a common challenge for fit-out works. The scaffold tower platform level was incompatible with the ceiling level and services installation task. Correct handrails could not be installed with the platform at the correct height.

Equipment (Immediate Accident Circumstance)
The suitability of the access tower was questionable in that the platform and handrail could not be installed at the correct height to suit the task being done. The platform manufacturer advised that towers with alternative module heights are available (so that different heights can be achieved), but are rarely asked for. The suppliers claimed that there was no feedback from construction users on user issues or accidents that occurred. There were some issues regarding the tower access hatch design and human interaction.

There are also possible suitability, usability and design issues for the harness manufacturers to reduce the likelihood of the harness snagging on adjacent works. It is questionable whether the harness and lanyard being used would have prevented injury had the operative fallen from the tower platform due to the fall distance for the restraint to be effective.

Risk Management (Originating Influences)
There was no risk assessment for this situation. The harness had been worn as a response to the perceived risk after the handrail could not be installed.

Permanent Works Design (Originating Influences)
The design and use of pre-assembled above-ceiling services would have significantly reduced or even removed the risk of this accident.

Vignette 3 – Accident 75

Accident background and information
"IP trod on a half-brick and turned his right ankle, which has swollen. The ground is made up with crushed brick material and it is inherent that these materials will be loose"
(*quote from accident report*).

The key aspects of this accident map across the hierarchy of influences as follows:

- Immediate Accident Circumstances
- Shaping Factors
- Originating Influences

Work Place and Materials (Immediate Accident Circumstances)
Clearly the work place was a causal factor with a local hazard being the brick rubble that was the specified material for the hardcore fill. The accident record commented that brick rubble is inherently 'loose' and apparently, two other employees had fallen due to the nature of the brick fill that week. The IP stated that there were "big lumps coming through the re-cycling system". He also added: "the problem is not just on this site - I was on a site similar to this and the same thing was happening". Notwithstanding this experience, nothing seemed to have been done about the risk.

The IP was walking across site when the accident happened, he stated that there was "plenty of room" and considered that the housekeeping was "generally very good", however, the trip hazard does not appear to have been covered in the risk assessment. There also do not seem to have been any designated walkways across the site which could have reduced the risk of tripping.

Design (Originating Influence)
The IP stated that "basically the machine doesn't chop it up fine enough - perhaps the designers need to look at the specification for this type of recycled hardcore." It is unclear whether this characteristic is well understood by designers and therefore whether its suitability should have been considered in the specification. The project was design and build so there would, in theory at least, have been the opportunity for construction input to the design. It is acknowledged that the use of re-cycled demolition rubble as hardcore fill is considered very desirable from a sustainability point of view.

Vignette 4 – Accident 77

Accident background and information
"The IP was putting a roof-trussed rafter up. He walked backwards along the working platform of the scaffold. At some point he stepped into a void in the platform created by two missing scaffold battens. Unknown persons had removed these. The IP knew they were missing and perceived this as hazardous but took no action to rectify it. The IP fell through the void injuring his ribs"
(*quote from accident report*).

The key aspects of this accident map across the hierarchy of influences as follows:

- Immediate Accident Circumstances
- Shaping Factors
- Originating Influences

Workplace (Immediate Accident Circumstances)
The condition and usability of the workplace were major factors in this incident. The IP, an apprentice carpenter, described the accident: "I was working on the scaffolding putting the roof trusses on with Joe (his mentor carpenter). There were some boards missing. I stood backwards and I fell through about 2 feet, hurting my side." The remedial action was the safety manager had the boards replaced and the scaffold checked. There were no obvious changes made to the construction processes.

There were indications that the weather was wet and windy. This task involved a complex crane lift and it is not clear whether the site conditions were a direct factor. It is also not clear whether there was sufficient space on the scaffold for the operation.

Work team (Immediate Accident Circumstances)
The site manager's description was "in my opinion this was self-inflicted. The system of work was not carried out, the scaffold boards had been moved by unknown parties which they (IP and mentor) knew about. The IP fell through the boards - he was very lucky he wasn't hurt more". In the interviews the whole issue of the boards being removed was passed from trade to trade and no one admitted to it. These comments suggest deficiencies in communication, supervision and attitudes, which in turn illustrate a poor safety culture.

The IP was being trained 'on-the-job' and his mentor was on piecework. It may have been that he was tempted to work when unsafe, although there is no specific evidence to this effect.

Risk Management (Originating Influences)
The IP stated that he had "never seen a method statement". The site manger said that "the safety manager prepared the method statement and risk assessment, normally as one document" which is then stored in the site office. He added that the MS's were typically "very generic" although the site operatives are "consulted over complex methods".

6.3 IMMEDIATE ACCIDENT CIRCUMSTANCES

The causal analysis presented in Table 15 demonstrates that, not surprisingly, the actions of individuals and site hazards featured in many of the accidents. It was interesting, however, that many of the accidents occurred 'off-task', either during preparatory activities or when individuals were moving around site. Also noteworthy was the high prevalence of material and equipment factors as accident causes, although it is possible the incidence of these within the sample may have been affected by the concentration of the research on 'minor' accidents. In these cases, deficiencies with material or equipment design, or their actual condition at the time of the accident, contributed to the failure. In many situations, the safety of those needing to handle the materials or use the equipment appeared to have been given little consideration by those responsible for their design, supply or purchase.

6.4 SHAPING FACTORS

Figure 15 categorises the intermediate factors affecting the immediate accident circumstances as worker factors, site factors or material and equipment factors.

6.4.1 Worker factors

Attitudes towards safety

Attitudes towards safety by those working in construction have no doubt developed over the past five years or so, with the increased attention there has been from regulatory authorities (eg HSE) and larger contractors. On the one hand, workers do not want to be injured themselves or be responsible for injuring others. On the other, the accident studies demonstrate that workers often engage in unsafe acts. It is suggested that the reasons for this are three fold:

- safety being overlooked in the context of heavy workloads and other priorities
- taking shortcuts to save effort and time
- inaccurate perception of risk, with feelings of invulnerability and 'it won't happen to me'

Underlying each of these are inadequate safety knowledge, pointing to deficiencies with education and training.

Developing safety knowledge and skills

A distinction should be made between education and training. Education imparts high level knowledge and skills, transferable to different situations. Training is more context specific, dealing with procedures or rules for undertaking particular tasks or activities. Effective education equips individuals with the ability to analyse a situation and respond accordingly. Training, however, provides more directive instruction as to how an act should be performed. A combination of both is desirable.

Training features widely in the industry at the moment, in varying forms and levels of formality. However, our interviews suggest the effectiveness of this is questionable when it comes to health and safety. Safety training is delivered by rote, by trainers with a poor understanding of what they are doing. Site inductions and tool box talks are examples of situations where this occurs. It is no surprise that such training fails to engage its recipients and this may well be harmful in the negative attitudes instilled towards safety. Where learning takes place 'on the job', this is likely to disseminate and perpetuate bad habits. Little exists by way of health and safety education for those at supervisory, managerial or professional levels, let alone for site operatives.

Supervision

Previous research has identified the important influence front line supervisors have on safety. It has long been argued that the supervisor, or front-line manager, is a key individual in accident prevention, having daily contact with staff and the opportunity to control unsafe conditions and acts likely to cause accidents (Heinrich et al, 1980; Chew, 1988; Simard and Marchand 1994). The literature suggests that the important aspects of supervisory behaviour in this respect include: attitudes and approaches to safety and training, nature and extent of interaction with employees, and thoroughness and willingness to learn from accident investigation.

The 100 accident studies suggest that front line supervisors in construction undertake very limited safety-related activity. Indeed, it was apparent from the interviews that construction supervisors frequently have little safety awareness and a poor understanding of accident causation and prevention. This is not surprising given the lack of safety education discussed in the preceding section. Coupled with this is the perceived conflicting priority of meeting project deadlines and a lack of positive incentives for individuals in a supervisory role to give safety their attention. In practice, working safely often means working efficiently and coincides with good project and work management (Strategic Forum for Construction, 2002).

Health and fatigue

The problems with the health monitoring of construction workers is widely recognised (Gyi et al, 1998; HSE, 2002). For operatives, in particular, there is rarely any effective pre-employment screening or health surveillance. This is in the context of physically demanding work, with inherent health risks. As demonstrated by this research, the consequence of this is workers on site with health problems, having accidents because of this. These accidents are then subject to inadequate treatment and rehabilitation before individuals return to work.

It is also apparent from this research that construction workers work long hours (Table 13). This might be the result of paid overtime for operatives or, in the case of managerial or professional staff, regarded as necessary due to a high work load. Although few direct linkages were found in the accident studies between tiredness or fatigue and specific failures, some accident-involved individuals had been working very long periods without a break, or several long days without a day off. The consequences of tiredness and fatigue are reduced concentration, poor decision making and compromised safety. This does not appear to be widely recognised in the industry.

Communication

Language difficulties were rarely an obvious factor in the accident studies (an exception being accident 22). However, it does seem likely that a poor command of spoken English could impair safety (as well as productivity) in situations where coordination is required. Language abilities appear to be assessed only informally (if at all) when individuals are recruited for work, with no explicit consideration of the implications for safety.

In other instances, poor communication within work teams contributed to incidents. In some cases this was due to the physical distance between work colleagues or high levels of background noise. This is likely to be a function of work planning as well as education and training. In situations where the importance of communication and coordination can be recognised in advance, technological solutions, making use of compact, wearable 2-way radio devices, might be worth trialling.

Problems with communication also arose at an organisational level. The fire in accident 23 happened due to deficient communications with the gas supplier, who had apparently given confirmation that the gas supply was off in properties undergoing renovation. The communication problems were compounded by poor safety procedures, which allowed the

communication failure to go unchecked. An observation made here is that in some circumstances, undue reliance is placed on informal communication, when the safety risk is such that a much more robust safe system of work ought to be in place.

6.4.2 Site factors

Local hazards on site were a feature in many of the 100 accidents studied. Problems included fall hazards, such as trailing cables, uneven ground or debris, and muddy conditions. Other accidents involved injury from protruding hazards such as nails or scaffolding components. These were often coupled with a lack of clearly defined walkways and poor housekeeping.

It was striking to the non-construction members of the research team how poor the situation is in these respects on most construction sites, even those considered to be 'well run' by industry standards. Industry representatives respond to this criticism, arguing that difficult site conditions are inevitable given the constantly changing workplace and work activities that occur in construction. However, pointing to the improved performance in site management on some engineering construction projects counters this perspective. From the perspective of those familiar with safety in a wide range of other industries, the poor site conditions found in construction appear to be a symptom of the weak safety and risk management culture in the industry.

Site constraints, typically inadequate space or difficult access to perform a task, were identified as a causal factor in some accident studies. In one of the more serious cases (11), insufficient room to extend stabilisers led to a delivery vehicle overturning. In this case, as in most of the others where site constraints were involved, inadequate planning coupled with poor local assessment of risk were probably key contributors to the incident.

Problems associated with outdoor working are frequently cited as one of the unusual aspects of construction, affecting the safety record of the industry. However, the weather appeared to be a factor in only a small number of the accident studies, despite the data collection for the research spanning the seasons.

6.4.3 Material and equipment factors

Materials

Several of the accidents involved hazards connected with materials. Hazards were either inherent to the materials, as with the extremely heavy 140kg steel angles in accident 5, or due to problems with the way the materials were supplied, for example the steel banding around plywood in accident 9. The point has been made previously that materials packaging can also cause problems with disposal, leading to other hazards being introduced onto site (eg fall or fire hazards).

Suppliers have paid attention to the manual handling requirements of some materials, through the introduction of smaller cement bags, for example. Unfortunately, this approach does not seem to have extended far, even with widely used generic items. There are situations where alternatives are available, but not in use due to reasons of custom and practice, cost or availability. In accident 1, an operative was carrying a reel of rebar tie wire, which caught on an obstacle and hit the individual in the eye when it released. The operative mentioned that he had worked on sites abroad where the tie wire came in convenient dispensing canisters, but that he had not seen these in the UK.

There are many situations where modest changes to materials or the way in which they are supplied could improve safety. However, at present, purchasers are not using safety as a criterion. Without this, suppliers have no encouragement to be innovative.

Equipment and tools

Similar issues exist with equipment and tools as with materials. A number of the accidents featured scaffolding. Some of the incidents involved falls through the scaffold, or problems when negotiating the opening from one level to the next. It is interesting that injuries in several accidents arose from individuals striking their head or other body parts against scaffolding protrusions. Scaffolding strike hazards arise from the manner in which scaffolding is assembled, either due to poor configuration, site constraints or equipment limitations. Accident study follow-up work attempted to explore what scaffolding design alternatives exist or are under development that could alleviate some of the indirect hazards arising from scaffolding. Unfortunately, the research team was not able to obtain relevant information from scaffolding manufacturers or suppliers as they were either unwilling or unable to comment. Although the design of scaffold towers, in terms of their convenience for erection and use, has received some attention, there is little evidence that ergonomics aspects of traditional scaffolding have been examined. This is another opportunity for modest innovation.

Discussions with interviewees in the accident studies revealed that tools are usually selected on the basis of price and performance. Durability may sometimes be a consideration but usability and safety do not appear to be purchasing factors. A number of the accidents featured tools or equipment that was in poor condition. It is to be expected that shared equipment, having multiple users, will be subject to heavy wear and tear. In such circumstances, scheduled inspection and maintenance are important, although there was little evidence of this in practice.

PPE

Despite a wide reliance on PPE as a control measure, this study again highlights the problems with such equipment. Much of the PPE found in use on construction sites at present is uncomfortable and interferes with the wearer's ability to perform their work. It is incongruous that in some instances the PPE itself resulted in significant accidents. In two cases (36 and 79), safety harnesses caught on surrounding items, causing an arm fracture in one accident and a back injury in another.

Problems with PPE mean that it is often only used when compulsory and where this is enforced. There are improved designs available, but these can be difficult to obtain and carry a higher cost.

A number of interviews raised the suggestion that a form of risk homeostasis might be operating, where provision of PPE, such as harnesses, makes workers feel safer, therefore leading them to take greater risk. Although the nature and extent of this remain to be confirmed, there is anecdotal evidence that in some situations this might be happening. This emphasises the important message that despite the current focus of risk management in the industry on PPE, it should only be a last resort. Elimination or reduction of the risk through other means, eg design, should be the priority.

There is a significant opportunity with the design of materials and equipment to improve safety, with many of the problems relatively straightforward to overcome. However, this will need much better liaison within the supply-purchase chain. The manner in which this operates at present appears to stifle developments.

6.5 ORIGINATING INFLUENCES

The originating influences in construction accidents are the high level determinates of the nature, extent and existence of the immediate causes of accidents. Elsewhere, these influences have sometimes been referred to using terminology such as 'root causes'. It seems very clear that these influences do affect safety on construction sites. However, this research has

demonstrated that the effects of these influences are subtle and that it is very difficult to trace through to these when exploring the causation of an individual incident. Hence the different vocabulary used in this report.

Permanent works design

Since European Directive 92/57/EEC was implemented in the UK, giving rise to the CDM regulations (HSC, 2001b), construction design has been a focus for those concerned with construction safety. Much of the attention, however, has been on compliance with the requirements of the regulations and the prescribed procedures. This in itself has not yet delivered the significant safety benefits expected from the legislation. There are of course complex reasons behind this.

Elimination or reduction of risks through design or alternative methods of construction is highly desirable. Frequently, construction design and construction process are interlinked, with the process being dictated by the design and decisions from the design team. Taking this into account, this research has found that up to half of the 100 accidents examined could have been mitigated through a design change. In many of the cases, this could have been by pre-assembly, with the construction work being moved off-site. An example of this is accident 92, where an electrician was installing cables in a ceiling void and suffered a deep cut to his arm from an exposed metal ceiling grid. An improved design would have avoided sharp protrusions, making allowance for installation and subsequent maintenance tasks. Moreover, pre-assembly of the above-ceiling services would have allowed the operation to be performed at a more convenient working height, without the workspace limitations encountered on site. It is recognised however, that pre-assembly may introduce risks elsewhere, and research currently in progress by the APaCHe team at Loughborough is seeking to compare and contrast these[1].

A significant finding from the follow-up investigations was that although some members of the construction design community are fervent advocates of designing for safety, these are the exception rather than the rule. Many designers are still failing to acknowledge their influence on the safety of the construction process. Where recognition of influence does exist, other conflicting priorities are cited, such as client requirements and cost. Underlying this response by designers is deep-seated custom and practice and an absence of safety education and training (Carpenter et al, 2000). Some interviewees mentioned that, in their experience, design and build project arrangements allowed many of the barriers to designing with safety in mind to be overcome. This is because the contractual arrangements place the responsibility for both design and construction elements within a single project team, leading to shared goals, improved communication, and a better environment for new ideas to flourish. Although it appears intuitive that such arrangements should help address some of the problems with the conventional project structure described herein, it was not possible to examine the detailed pros and cons of different contractual arrangement within this research.

Although half of the accident studies might have been prevented by design, the corollary is that half could not. The proportions here might be subject to sampling bias, due to selection of less serious accidents but, nonetheless, many of the incidents were caused by commonplace hazards and activities that will continue to occur on site whatever design changes might be made. The widespread presence of the many generic safety risks accompanying construction needs to be tackled before the benefits of design improvements will be realised.

[1] *'The effect of standardisation and pre-assembly on health, safety and accident causality in the construction industry', funded by the Engineering and Physical Sciences Research Council, due for completion summer 2003*

Construction processes

As a part of each accident study, the relevant method statements were requested, with consideration then given to how the incident mapped on to these. It is interesting to note the significant proportion of accidents for which no method statement was applicable. This was often because the accident happened away from any particular construction task, while the accident-involved individual was moving around site or engaged in an activity regarded as a core skill.

As indicated above, construction processes are often a function of the permanent works design. There are many aspects of the construction process, though, which are left to the discretion of site personnel. This is fine detail beyond that specified in the design instructions. It was apparent from the interviews that tension exists over precisely where the boundary should lie in the division of responsibility between the design and contractor teams. Whoever does assumes responsibility, an important finding from the accident studies is that safety currently does not receive adequate consideration in the decision making. This research found no evidence that sources of advice which assist with risk evaluation had been used, for example guidance published by CIRIA on the risks associated with alternative designs and construction methods (Ove Arup & Partners, 1997).

Project management

A clear influence from problems with project management were identified in only a quarter of the accident studies, although this is likely to have been because the precise effects are difficult to corroborate. This research supports previous findings (Gyi et al, 1999) regarding the negative implications for safety that arise from the sub-contracting arrangements within the industry. This leads to problems with blurred responsibility and difficulties with communication between one contractor and another.

Current difficulties with labour supply for the industry were said to affect the ability to appoint appropriately skilled workers, this in turn affecting safety. Although there were instances in the accident studies where workers had been reckless, there were few cases where it was obvious that the accident-involved individuals did not have the necessary skills for the work (although there were some). Rather than deficiencies in the skills needed for their specific tasks, the problems appear to lie more in a widespread poor level of safety awareness. Current methods of addressing this, for example site inductions and toolbox talks frequently do little to improve the position and in some instances may make matters worse, through cultivating a negative attitude towards health and safety.

It is likely that the problems with labour supply account for the cases within the studies where accident-involved individuals had a poor command of spoken English, as discussed previously in section 6.4.1.

Deficiencies in project management and planning can lead to difficulties with the project schedule. These in turn result in time pressure on all involved within a project, with subsequent problems such as trade overlap, crowded workspaces and reduced attention to detail. Around 1 in 10 of the accident studies were in the context of project scheduling problems. Although a feature of these incidents, the extent to which this may have been causal is uncertain.

Safety culture and risk management

It is not particularly surprising that Table 15 should identify deficiencies in risk management in most of the 100 accidents studied. Accidents invariably involve an inadequately controlled risk, indicative of a management failing. Echoing the findings of previous research, it is again noteworthy that most of the 100 accidents studied for this research could have been foreseen and were preventable.

Frequently, no risk assessment existed for the accident activities, despite this being a legal requirement, even for activities 'off-task'. Even where risk assessments did exist, these often formed part of a method statement, the applicability of which to actual work circumstances was often limited. This is indicative of a poor safety culture within the industry.

The evidence from the accident studies leads to the conclusion that there is a pervasive failure of the industry to engage in effective risk management. Where risk assessment had been attempted, this was largely a paper exercise, unlikely to have any real effect. Elsewhere, an over reliance on PPE as a control is used as a substitute for eliminating hazards and reducing risks through more direct means. When accidents do happen, there is limited accident investigation, undertaken for the wrong reasons. The findings of these frequently contain an over attribution to 'chance', and a tendency for over apportionment of 'blame'. Another important shortcoming of the accident investigation processes in the industry is an absence of effective remedial action.

Achieving real safety improvements in construction will require effort at all levels directed at the active identification and control of risks. Although risk management is not always undertaken thoroughly in other industries, the widespread deficiencies of this in construction are striking.

High level influences

There was little direct evidence of the influence of client requirements or the economic climate on the accidents studied for this research. While these undoubtedly do affect construction safety, there was only one instance in our dataset where it seemed requests from clients might have led to an increased risk. This was with respect to the high frequency of architect instructions in accident 25. The economic climate in which construction activity takes place affects competition for projects, pricing, availability of labour and so forth. All of these are likely to impinge on safety, but it proved difficult to make direct connections in the individual accidents examined by this research.

Problems with education and training have been discussed in section 6.4.1, in connection with site-based personnel. When it comes to the education and training of architects, designers, engineers and surveyors, other research commissioned by HSE (Carpenter et al, 2000) has identified that the provision of health and safety education in construction related university degrees is poor. This was, however, in the face of inadequate requirements for health and safety education by the accreditation bodies which regulate the professions. A need exists across the industry, encompassing designers and suppliers as well as site based personnel, to raise awareness and understanding of the generic health and safety risks that are commonplace in construction.

7 CONCLUSIONS

7.1 FULFILMENT OF RESEARCH AIMS

Accidents in construction, as with accidents elsewhere, are the multi-causal outcome of a sequence of events. Acknowledging this complex aetiology, the aims of this research were:

1. To collect rich, detailed data on the full range of factors involved in a large sample of construction accidents.

2. Using this information, to describe the processes of accident causation, including the contribution of management, project, site and individual factors in construction industry accidents.

A series of initial focus groups held with industry stakeholders allowed the wide range of issues considered by participants to be involved in construction safety to be identified. These factors were then examined in detail through studies of 100 accidents. The accident sample encompassed a broad range of construction activities, site conditions and accident types. For pragmatic reasons, the accident studies had to be confined to less serious incidents, although the analysis presented in section 4.3 and Appendix C demonstrates that almost all of the accidents had the potential to be much more serious.

7.2 RESEARCH FINDINGS

This research has demonstrated how construction accidents arise from a failure in the interaction between workers, their workplace and the materials and equipment they are using (Figure 15). Each of these elements is affected by various shaping factors, varying the extent to which risks may be present and controlled in the work activity. For example, the design, specification and supply/availability of materials and equipment affect the suitability, usability, condition and ultimately safety of items and supplies that find their way into the hands of operatives. In turn, originating influences, including the permanent works design, construction processes and safety culture bear upon these shaping factors.

The research has found that:

- Problems arising from workers or the work team, especially worker actions or behaviour and worker capabilities, were judged to have contributed to over two thirds (70%) of the accidents. This points to inadequate supervision, education and training.

- Poor communication within work teams contributed to some accidents, due to the physical distance between work colleagues or high levels of background noise.

- In many cases, the accident occurred when those involved were not actually performing a construction task, but moving around site, for example.

- Workplace factors, most notably poor housekeeping and problems with the site layout and space availability, were considered to have contributed in half (49%) of the accident studies. Standards of housekeeping and workplace layout with respect to safety are low in construction when compared with other industrial sectors.

- Despite poor weather often being cited as one of the reasons for construction having a poor safety record, this research found little evidence in support of this.

- Shortcomings with equipment, including PPE, were identified in over half (56%) of the incidents. Poor equipment design and inappropriate use of equipment for the task were prominent aspects of this. Designers, suppliers and purchasers of equipment appear to give insufficient attention to the safety of users.

- Deficiencies with the suitability and condition of materials, including packaging, featured in more than a quarter (27%) of incidents. The operation of the supply/purchase chain at present appears to act as a barrier to innovation as far as safety is concerned.

- Originating influences, especially inadequacies with risk management, were considered to have been present in almost all (94%) of the accidents.

- Frequently, no risk assessment had been undertaken covering the circumstances involved in the accident. Where a risk assessment had been carried out, it was often found to be superficial and unlikely to have prevented the accident.

- It appears that PPE is relied upon habitually as a substitute for risk elimination or reduction at source.

- It was judged that up to half of the 100 accidents could have been mitigated through a design change and it was found that, despite CDM, many designers are still failing to address the safety implications of their designs and specifications.

- Accident investigation by employers or supervising contractors is frequently superficial and of little value as far as improving safety is concerned. It appears that HSE investigations generally focus on safety failures in the activity being undertaken, without capturing the upstream influences upon these.

- The influence from clients on safety appeared limited in the construction sectors predominant in this research (civil engineering, major building, residential). This was, again, despite the responsibilities on clients imposed by CDM.

- Many of the incidents were caused by commonplace hazards and activities that will continue to occur on site whatever design changes might be made. The widespread presence of the many generic safety risks accompanying construction needs to be tackled before the benefits of design improvements will be realised.

Together, these factors point to failings in education, training and safety culture in the industry. A large majority of those working in construction, both on and off site, continue to have only a superficial appreciation of health and safety considerations.

7.3 WHAT SHOULD BE DONE?

Achieving a significant and sustained reduction in accidents will require attention at all levels of the hierarchy of causation described by this research. Important points are:

- Responsibility for safety needs to be owned and integrated across the project team, from designers and engineers through to skilled trades personnel and operatives.

- Other research has shown how the lead given by front line supervisors has a strong influence on safety performance. Worker participation in managing safety is important, to generate ideas and to build ownership and responsibility.

- Where safety depends on communication and coordination, it is important that a robust safe system of work is established.

- A step change is required with standards of site layout and housekeeping. principal contractors should raise expectations of what constitutes acceptable practice.

- Greater attention should be given to the design and selection of tools, equipment and materials. Safety, rather than price, should be the paramount consideration.

- There needs to be greater sophistication with the design and use of PPE. Current PPE is often uncomfortable and impedes performance. Forcing workers to wear PPE when risks are not present is counterproductive. PPE should be a last rather than first resort for risk management.

- There is a need across the industry for proper engagement with risk assessment and risk management. Emphasis should be on actively assessing and controlling risk, rather than treating risk assessment as merely a paper exercise.

- Construction should be encouraged to benchmark its safety practices against other industries. The excuse that construction is 'different' in some way does not stand up to scrutiny.

- Greater opportunity should be taken to learn from failures, with implementation of accident investigation procedures, both by employers and HSE, structured to reveal contributing factors earlier in the causal chain.

- It is important that 'safety' is disassociated from 'bureaucracy'.

- Frequently, safety does not have to come at a price. Where there are cost implications, however, regulatory bodies and trade associations should work to make sure there is a level playing field.

Most of these changes depend on achieving widespread improvement in understanding of health and safety. Education is needed over training, so as to promote intelligent knowledge rather than unthinking rule-based attention to safety.

Since this research commenced in the autumn of 1999, there has been welcome progress addressing some of these matters (eg Myers, 2003). However, much remains to be done before we can expect to see a significant and enduring reduction in the number of people killed and injured by construction operations.

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APPENDIX A

ACCIDENT STUDY PROFORMA

ACCIDENT NOTIFICATION – PROFORMA 1

Contact person name	Telephone & fax number	Email	Site / contact address

Avoiding overlap with HSE investigation		
Was the accident reportable?	Yes/No*	We wish to avoid overlap with ongoing HSE involvement. If you have answered 'YES' to any of these questions, please contact us before completing the remainder of the questionnaire.
Has HSE been notified (if applicable)?	Yes/No*	
Has any HSE investigation begun?	Yes/No*	

About the accident – duplicate the record from the accident book

Who (discipline) made the entry:

Details of incident conditions

Job title of IP -

Time, month and day of week –

Task / activity –

Tools / materials / equipment –

Environment –
(conditions of light, noise, temperature etc..)

Site location –
(Level / area)

Build data

Contract type –
(Design & build , Construction management etc..)

Project value –

Build type and phase* -

Principle contractor -

Numbers on site –

Brown / Greenfield site -

Site start and finish dates -

Timeliness of build –
(late, on-time, ahead etc..)

Access to accident involved personnel	
Are operatives from the accident vicinity available for interview?	
Injured party contact details	
How can we get in touch? Please provide the hospital contact details or name and address for further contact (Employer, home or new work address)	

Site resources
Can copies of the following resources be provided (anonymise by 'blacking out' any detail such as names etc.. if you prefer) • The accident report • Method statement • Risk assessment • Site organisational chart • Other relevant procedures / documentation

*BUILD TYPE	PHASE
Engineering construction	START - Demolition, site clearance, excavation, substructure, drainage, ground- works etc..
Rail and Civil Engineering Major build	MIDDLE - Structure, superstructure, cladding END - Finishes, M&E (mechanical and electrical), commissioning, snagging
Residential	AFTER - Maintenance

History of accident victims direct employer / appointer			
Is the employer: - a PC - a major SC - a sub-sub contractor - other	Please specify place in chain	Nature of business / speciality	
Number of employees in company		Who contracted the employing company	
Length of time employing company on this site		Has employing company previously worked with this Principle contractor	
Is there a history of previous related accidents and any subsequent changes?			

Accident involved personnel – Proforma 2

Accident involved profile:

Job title: What does your job entail	

Accident data

Accident summary: Describe what happened
What action was taken afterwards to prevent recurrence?

1. Environmental

2.1.1	What were the site conditions at the time of the accident (ie: *temp, light, noise, vibration, wet*)	
2.1.2	Any measures to compensate for adverse conditions *(ie: task lighting / platform etc..)*	

2. Task details

2.2.1	What work were you doing *(Task description(s))*	
2.2.2	Were you undertaking a number of tasks simultaneously - what was the time proportion at each	
2.2.3	Rate difficultness of this task	1(v easy) – 2 (fairly easy) – 3 (average) – 4 (quite difficult) – 5 (v difficult)
2.2.4	Did you have the skill and experience to undertake this task	
2.2.5	When was task training last received & how	

2.2.6	Were there any task interruptions?	
2.2.7	Were there any known risks in task? (*e.g. chemical, electrical, mechanical)*	
2.2.8	Were there any unusual events or changes *(eg. in schedule / design / improvisation)*	
2.2.9	Was apprentice training / supervision in progress?	
2.2.10	Was lone or gang work being undertaken	

3. Describe task / work area & interaction

2.3.1	Do you have any comments on height / space / movement / placement aspects for: • operatives • plant & material movement	
2.3.2	Describe plant / materials / tools / equipment being used:	
2.3.3	Which were your own and which were provided?	
2.3.4	How do chose your own equipment ? * Is there a range available for your work task * Have you always used this product * Has anyone advised you that this is good * Are there specific features that you like	
2.3.5	Have you ever received instruction / training on the use and maintenance of your own tools	
2.3.6	Do you have any comments upon preferences, quality, maintenance, availability, interface, usability (of plant / materials / tools / equipment)	

2.3.7	Have you had specific information related to what you were using • Training in use • Information from suppliers	
2.3.8	Do you have any comments on housekeeping: *(standards, management, responsibilities for)*	**(General and at time of accident)**
2.3.9	Have you ever reported any problems about your work relevant to this accident?	
2.3.10	(i) Do you know if anyone else has had a similar accident (ii) What action was taken	
	Comments	

4. PPE

2.4.1	What protection do you use at work?	
2.4.2	Is it specific for this task	
2.4.3	Who provides this equipment?	
2.4.4	Have you had training in use & care of this equipment?	
2.4.5	Any comments on availability, range for fit and function, comfort, usability, condition, storage, maintenance	

5. Procedures / MS's / RA's / (PTW's)

2.5.1	Were there procedures / instructions for this task?	
2.5.2	Concerning procedures / instructions * How did you learn about these? * When and where did you last view them * Did you read them in detail * How long did it take	
2.5.3	Did the procedures / instructions tell you: • What to do • What techniques to use • What risks there were	
2.5.4	How easy were they to understand	1(v easy) – 2 (fairly easy) – 3 (average) – 4 (quite difficult) – 5 (v difficult)
2.5.5	For your work was the information: • helpful • appropriate	
2.5.6	Were procedures followed or were other work methods necessary	
	Comments	

6. Work scheduling

2.6.1	How frequently do you do this task?		2.6.2	Did you have sufficient time to do this task?	
2.6.3	How long had you been doing this task before the accident happened?		2.6.4	How long had you been working (general) since your last break?	
2.6.5	When was your last day off work prior to the accident day?				

7. Welfare

2.7.1	Are your breaks adequate?		2.7.2	Are comfort breaks permitted (*ie: toilet / drink of water*)?	
2.7.3	What do you think of your welfare facilities (*ie: food, drink, loos, changing*)?				
	Comments				

8. Work organisation

2.8.1	At the time of the accident was there any trade overlap – *(ie: yourself and different trades people working together / close by)?* • Was this planned / unplanned • Were you consulted about this?	
2.8.2	Were your co-workers / other trades people known to you?	
2.8.3	Were adequate personnel available for the task?	
2.8.4	Have there been any recent changes in the way that your work is organised?	
2.8.5	Who sets-up your work arrangements	
2.8.6	Are you consulted / included in discussions about • your work organisation • safety related issues	

2.8.7	Is there a production target to meet? How is it • determined, • overseen • rewarded	
2.8.8	Were there any time / production pressures • how from whom	
	Comments	

9. Work pace

2.9.1	How do you decide how to pace your work rate? • Decide yourself • Someone tells you • Gang decided together • Other	
2.9.2	Does it make a difference if a gang member is slower / faster than the others?	
	Comments:	

10. Target / Payment issues

	What is your payment method • Fixed wage • Priced work (note criteria for this) • Pay based on experience or training • Other	
	Do you receive any incentives to increase your pay?	
2.10.3	Which payment and or incentive methods do you prefer and why?	
	Comments	

11. Supervision / management

2.11.1	Was the Supervisor or Manager • Present when the accident occurred OR • When were they last seen prior to the accident?	
2.11.2	Do you think that you were adequately supervised	
2.11.3	Do you know your supervisor well?	
2.11.4	Do you find your Supervisor • Approachable • Receptive if you wish to report a problem	
	Comments:	

Individual details – Proforma 3

It would really help us to know more general things about you, as this too will help us to learn more about the people who work in the construction industry and the problems that you face

1. Personal details

3.1.1	Job title				
3.1.2	Gender		3.1.3	Age	
3.1.4	First language & fluencies		3.1.5	Accommodation arrangements during work time (home or away)	
3.1.6	What are the work hours (& breaks) per week + overtime? * for yourself * others from your company on site				
3.1.7	Are you able to chose if you do overtime or not?				
3.1.8	How much time off have you had in the past 12 months for? • Holidays • Sickness				
3.1.9	Were you paid for these absences?				
3.1.10	Do you do any paid work outside of your job here?				
3.1.11	What are your daily travel times and distances?				

2. Accident history

(Accidentee only) Previous accident dates and consequences:	

3. Employment history

3.3.1	Are you self-employed, employed by PC / Main sub-Contractor / sub-sub contractor / other?				
3.3.2	What is your length of service on this site?		3.3.3	What is your length of service with this employer?	
3.3.4	What is your length of service in this job and industry?		3.3.5	Do you have other previous employment? (type & duration)	
3.3.6	Do you feel that your employment is secure * With this company *In the industry		3.3.7	Do you belong to a trade union? (if so, which)	
3.3.8	Do you feel that you have an appropriate level of responsibility in your work?				
3.3.9	Do you have opportunities to use all your skills and abilities?				

4. Training history

3.4.1	What is the original baseline training that you had for your work? (ie: apprenticeship / professional training)	
3.4.2	In the last 5 years have you attended other shorter (1-2d) training courses? Please record • Area covered • Duration (*eg:* machine operation, supervisory skills, health and safety)	
3.4.3	What and when was your most advanced training in safety related aspects?	
3.4.4	**(This Q not for accidentees)** Have you had any training in human capabilities and performance? (and when) [Physical & mental capacities, such as strength, endurance, work over/under load, social factors etc…]	
3.4.5	**(Accidentees only)** What tool box talks have you have had in the last 3 months?	
3.4.6	Do you consider the training and apprenticeships (and access to these) adequate?	
3.4.7	Concerning site inductions: • Estimate the number you have had • Do these offer value to you	

3.4.8	How do you perceive the safety culture on this site	
	Comments	

5. Health related issues

(Q's for accident involved personnel only)

3.5.1	For someone of your age, how would you describe your general health?	
3.5.2	Have you suffered or do you have any ongoing health problems *(Briefly describe)* • Has this had any implications for your work and how? • Have you sought assistance / advice (what? and from whom?)	

6. Work perception

3.6.1	What are the best parts of your job	
3.6.2	What are the worst parts of your job	

Below are statements which will help us understand how you perceive your general work situation. Please answer ALL statements and indicate the extent to which you agree or disagree by circling the appropriate number on the scale.

	Completely disagree				Completely agree
I enjoy my work	1	2	3	4	5
My job meets my expectations	1	2	3	4	5
I can turn to a fellow worker for help when I have a problem	1	2	3	4	5
I get satisfaction from my job	1	2	3	4	5
I like most of my fellow workers	1	2	3	4	5
My job is mentally demanding	1	2	3	4	5
I enjoy the tasks involved in my job	1	2	3	4	5
My fellow workers talk things over with me	1	2	3	4	5
My job involves a great deal of mental concentration	1	2	3	4	5
I am happy with my job	1	2	3	4	5
My job involves a great deal of responsibility	1	2	3	4	5
I would recommend my job and place of work to a friend	1	2	3	4	5
My job causes me worry	1	2	3	4	5
I would chose the same job in the same place again	1	2	3	4	5
My fellow workers accept and support my new ideas	1	2	3	4	5

(Symonds, et al, 1996)

Comments:

FINALLY - Is there anything that you would like to say about your work or workplace or can you suggest how your work or workplace could be improved ? (Record overleaf →)

Site Supervisors / Managers / Safety personnel – Proforma 4

1. Baseline data

4.1.1	Job title What does your job entail *	
4.1.2	If you have knowledge of the accident, what do you think caused it?	
4.1.3	What action was taken afterwards to prevent recurrence?	

2. The work in progress

4.2.1	Was there anything difficult about this task	
4.2.2	Were there any aspects concerning tools, equipment or materials that made this task difficult	

3. Managing design revision (as appropriate)

4.3.1	Were there any recent design revisions relevant to the work in progress? • Temporary works • Permanent works • Other	
4.3.2	If you were required to make the above design revisions how did you handle this? *(ie: procedures used and disciplines involved)*	

4.3.3	Were there any problems with getting design drawings revised	
4.3.4	Were site staff involved in revision of design drawings *(ie: record relevant disciplines)*	

5. Scheduling the work

4.5.1	If there were any delays what caused them? (eg: starting the task, the schedule or work in progress),	
4.5.2	Were the skilled people required for the accident task available when you needed them?	
4.5.3	Did any unexpected work have to be absorbed into the existing work schedule	
4.5.4	Were there any unplanned changes? (eg: in work sequence, trade overlap* etc..)	

* trade overlap – two or more trades in the same work area simultaneously

6. Organising the work

4.6.1	In general, how do you assess the competence of new starters?	
4.6.2	(i) Do you do anything to ensure health status of new starters (ii) Do you offer any health surveillance for your operatives	
4.6.3	Are the operatives employed or self-employed to your company	

4.6.4	Do you discuss trade overlap directly with the trades themselves?	
4.6.5	What arrangements are there for worker consultation or liaison with: • Trade Unions • Safety representatives	
4.6.6	In planning team work, do you have any criteria for putting together your choice of people into a gang? (eg: previous knowledge of character, performance etc..)	
4.6.7	Were you able to meet these criteria when putting together the gang in the accident?	
4.6.8	Have you ever felt pressured to proceed without the correct materials or equipment?	
4.6.9	If you organise sub-contracting, how do you identify when you need to do this?	
4.6.10	For the accident task were / are any of the SC skills available among your own operatives?	
4.6.11	How have you co-ordinated activities and communication among the contractors	
4.6.12	How have you ensured compliance with the site rules and H&S plan	

4.6.13	How did you provide training and information on risks to: • Contractors • Operatives	
4.6.14	(i) Does you appointment specify any responsibilities for the H&S of people you oversee? (ii) Are there any written standards / instructions for you to follow? (iii) If so, is your performance in achieving these ever reviewed?	

7. Work pace

4.7.1	Do you do anything to motivate your operatives to increase productivity?	
4.7.2	How do you ensure that this does not compromise safety?	
4.7.3	If there were time pressures at the time of the accident were there any consequences to this?	
4.7.4	Is there any competition among contractor teams on site, to complete work quickly?	

8. Pay related issues

4.8.1	Is there any conflict between working safely and maintaining earning potential?	

9. Supervision / management

4.9.1	During the accident task was there adequate: • Supervision • Project Management	
4.9.2	In hindsight, and in relation to the accident task, were there any hazards that should have been acted upon or reported	
4.9.3	Have you ever previously received complaints relating to the accident tasks & what action was taken?	

10. PPE

4.9.1	Who (which discipline) chooses the PPE range	
4.9.2	What attributes leading purchase choice (perhaps good feedback from users, price, function etc..)	
4.9.3	When did you last select a new product or style & why	

11. Information transfer – paper based

4.10.1	Which disciplines prepared the • Method Statements • Risk assessments	*(In general & for accident task if different)*
4.10.2	Were the MS and RA: • Different documents • Integrated together as one document	
4.10.3	What is the sequence of processes to prepare the: • Method Statement • Risk assessment	
4.10.4	What materials do you need to prepare these (eg: *drawings, information from managers etc..)*	
4.10.5	Were these materials suitable for their purpose?	
4.10.6	If any, which disciplines at site level were consulted about content	

4.10.7	How is the information • Stored • Made available to all personnel	
4.10.8	When did you last read the materials?	
4.10.9	Is the information ever reviewed and evaluated	
4.10.10	Are there any additional resources to instruct people? (procedures, posters, notices etc..)	

12. Information transfer – practical

4.11.1	What did the site induction entail?	
4.11.2	What instruction or training was provided to undertake the accident task?	
4.11.3	Has the accident task ever been the subject of a tool-box talk & when	
4.11.4	Have the induction / instruction / training methods been reviewed and evaluated	
4.11.5	Would you improve the above, given the opportunity and how	

APPENDIX B

ACCIDENT SUMMARIES

Accident Summaries

Case study	**01**		
Construction type[2]	Major Building	**IP Role**[3]	Steel Fixer
Construction phase[4]	Middle	**Employer status**[5]	SC
Timeliness[6]	Unknown		

Accident description[7]

Steel fixer was tying and carrying wire across top reinforcement mat of a concrete pour. End dragged behind him, snagged, he pulled it and it sprang back and hit him in the eye causing a laceration needing surgery.

Emerging Issues[8]

- Poor material (quality / presentation for use / weight / storage / resolution of known problems)
- Poor work environment - No shelter from weather
- Walking across mat - Balance and concentration issues
  Were walking boards available? Convenient? Being used? Properly supported/fixed?
- Inadequate supply / communication re. PPE
- Long work hours and overtime plus travel
- Time pressure
- Safety culture problems
- Poor method statement preparation and info transfer (consultation confused and information read to new operatives)
- High dependence on core skills (refresher/management supervisory skills not happening?)
- Some dissatisfaction among mid-level management grades re - communication and fulfilment
- Poor tool usage (inadequate design, not supplied, not PPE compatible)
- Planning issue – provision of equipment (weekly planning meeting)
- Unclear arrangements for prescription of technical solutions by designer or selection by PC

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[2] **Construction 'Type'**

Eng Construction	*Engineering Construction - Petro-chemical / Power generation etc*
Residential	*Residential both low and high-rise*
Civil Engineering	*Road / rail / bridges etc)*
Major building (MB)	*Commercial / Industrial building*
Refurbishment	*Refurbishment / renovation*

[3] **IP Role**

Role of involved / injured person as given at the interview

[4] **Construction Phase**

Start	*Site set up / preliminary works*
Middle	*Main construction work*
End	*Finishing works / 'snagging' / commissioning*

[5] **Employer status**

PC	*Principal contractor*
SC	*Sub-contractor*

[6] **Timeliness**

Progress on site relative to planned programme

[7] **Accident Description**

Taken from accident book and interviews with IP and supervisor

[8] **Emerging Issues**

Taken from consideration of the interview and project data collected by interviewer and additional expert reviews (construction and human factors)

- Time pressure when designing concrete frame
- No risk assessment from designer to PC about this concrete frame work
- Designer training in H&S limited
- Prefabricated reinforcement?

Case study	**02**		
Construction type	Residential	**IP Role**	Joiner
Construction phase	Middle	**Employer status**	SC
Timeliness	Late		

Accident description
Joiner was using a mitre saw to cut diagonal braces for window sub-frames. After making a cut he raised up the control handle of the saw and went to turn over the wood to cut mitre the other end of the piece. Although in a raised (non-operational) position the mitre saw guard had jammed (fragment retrieved – 35mm x 2mm deep) . This went unnoticed and the operative experienced a severe hand cut from the still spinning blade as he reached towards the wood piece.

Emerging Issues
- Indication that not much induction required for 2nd fix joiner – IP not finding inductions relevant to self
- RA/MS used as a training method
- Technique not reviewed or considered as an influencing factor
- Respect for previous skills / experience over-road supervision / training / TBTs / formal H&S Mgmt measures - Several references to reliance on core competencies (such as contractor and carpenter skills)
- No training in human capabilities and performance
- Un-stimulating task
- Fairly low tolerance of people who aren't on the ball / sharp.
- Job satisfaction appears high
- Long work hours and driving +++
- Poor mitre saw design
- Slither jamming saw implicated as joiners fault and not a saw shortcoming
- No instructions about using a circular saw? Is this appropriate?
- Poor / absent purchasing policy (saw)
- Indication of poor manufacturers instruction concerning temporary frame for window
- Impact of PPE unknown
- Work area not as desired by joiners - Joiners workshop not allocated in site plan
- Time pressure—due to unexpected demand and prospective loss of employee
- Unsupervised work - information about sudden workload not conveyed to Supervisor / Mgr by joiners
- Thoroughness / range of safety management not necessarily perceived by SC firm
- SC Manager workload appears quite stressful
- No distinction between RA /MS
- Felt that this method of cavity closure was a 'design innovation' &superior to former method, as this avoids the need for scaffolding & 'timber handling'
- Original design was revised for cost reasons, but this was deemed acceptable (from a safety perspective) by Architect
- Architect not aware of bracing requirements for window build

- Liaison with window & cavity closure manufacturers was undertaken but it seems that the issue of window bracing requirements was not addressed
- It was the contractor that chose this window type - does ownership / responsibility get lost / blurred, the more people are involved??
- Client had quite a lot of impact upon the design – time pressure upon designer, choice of window style, cost aspects BUT would window build have been much different even if there had been a more free reign?
- There was no formal design development for the windows – they just followed 'off the shelf' protocol
- Window build has no safety specification as it is standard building practice
- Expects contractor to safeguard Safe Working Practice of ops (carpenter)
- If the cross-bracing had been undertaken in a factory, would the carpenter then start to loose his mitre saw skills & become more vulnerable?
- He showed a clear preference for 'design and build' and 'partnering' where the Architect & contractor are involved from an early stage improving buildability. The alternative sees contractor developing a lot of 'un-drawn design' on their own initiative.
- PS role seems to have been 'juggled about a bit' – Architects were PS until PC tender accepted. After this the detailed drawings were developed for the design – did PC exercise their PS role adequately re. the window design OR has nobody considered the task of bracing?
- Not that happy about usability of CDM and guidance from HSE

Case study	**03**		
Construction type	Major Building	**IP Role**	Fitter
Construction phase	Decommissioning	**Employer status**	??
Timeliness	On time		

Accident description

Decommissioning phase. Operative were using an angle grinder in a small room (Size Reduction Area) within a radiological decontamination area (Dismantling area). It is thought that sparks flew off and ignited the filter of an extractor fan unit causing a fire. No injuries to personnel. As fire was being extracted from the work area it, the alarm was raised by Ops in the room next to that where the work was carried out.

Emerging Issues

- Ops not familiar with operating fan / emergency switch
- Switch on outside of work area only
- Position of smoke detector inappropriate?
- Fan filter inadequacy – Manufacturers unaware
- Adequacy of in-house fan cover design questionable
- Attempt to evade responsibility – blame culture
- Cost implication of tooling – all to be disposed of
- Fire watch inhibited by PPE
- Unanticipated and additional training demands of local labour for PC
- Adequacy of risk assessment

Case study 04

Construction type	Major Building	**IP Role**	Frame construction
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
A sub-contract scaffolder was picking up steel wedges (at a lower level ~ 3 ft) by a column that was being struck by a carpenter. Whilst he was doing this a loose 'acrow' prop fell onto his lower back

Emerging Issues

- The 2nd scaffolder started being interviewed but withdrew half way through as he thought interviewer was asking too much about his job, which he felt was irrelevant to the accident & misleading. He felt interviewer should be asking why the carpenter had not followed procedures?
- The carpenter stated that he had followed procedures – contradicted by scaffolders and Safety Officer
- There was trade overlap relevant to accident, but both employee groups felt justified in being there
- Both employee groups were overseen by a foreman, but otherwise organise their own work pace
- The Safety Officer had not identified that the scaffolders were there to erect a handrail behind the column, just that they shouldn't have been there
- The carpenter works on a price per column worked – time pressure implications
- The carpenter seems to work on a job and finish scheme (60 miles each way - home to work)
- The carpenter was reluctant to take time out for an interview- would lose work time
- Time pressure not perceived by either employee discipline
- Scaffolder felt that the prop should be fixed top and bottom, but this was not reported by the Safety Officer – apparently no industry-wide accepted method
- PPE seems to be a source of discomfort for scaffolder
- Carpenter has previous musculoskeletal injury to back and elbow which, he feels, are work related?
- Rudimentary design of materials involved
- NB: Company were unwilling to ask the Foreman to be interviewed as they felt he would probably be too busy / not keen to participate

Case study **05**

Construction type	Major Building	**IP Role**	Panel fixer
Construction phase		**Employer status**	SC
Timeliness			

Accident description
A panel fixer was working with his supervisor (also his Uncle) moving steel angles that had been delivered to the work area by others. Movement was achieved by carrying an end each; laying down was achieved by crouching down and then each person drops their end down in turn. This time both dropped their end together – IP somehow had his fingers beneath the falling material causing a wound to right middle finger

Emerging Issues

- IP had no experience of manoeuvring steel angles
- MH trainer (also 2nd person) 300mm taller than IP – shows a fundamental lack of understanding of a 2 person lift
- Load also greatly exceeds guide load in MH (Manual Handling) Regs.
- Technique could have been done using a sling & MH could have been avoided / greatly reduced
- Described non use of sling as had always managed before, but had also stated that this is first time with steel angles
- Would half size steel angles been appropriate for the build, but would that then make people even more likely to MH them
- Impression of time pressure from brickies, but no perception of this by site supervisor
- Impression from Site Supervisor that there is generally insufficient consultation re build with Management Contractor
- Also seems that culture is that SC goes ahead with decisions that earlier in project might have been made by PC Mgr
- IP couldn't keep up with speed of taller co-worker
- IP described lack of consultation / opportunity to contribute in decision making
- Both interviewees happy with task supervision – but supervisor seems to have failed in MH training and in realising that trainee needs more time/ opportunity to communicate
- IP not sure about whether MS followed, but thought that MS was appropriate in any case – institutionalisation re this process
- Countersignature to defer responsibility from SC to individual? Any legal grounding at all.
- General MH was a previous TBT, but learning from this as a not applied for this task
- MS – no reference to possible consequences of handling requirements

Case study	**06**		
Construction type	Major Building	**IP Role**	Cladding
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

A fixer / glazer was descending a scissor lift. In descending the platform, he mistakenly caught his wedding ring against a protrusion at the side of the handhold area. Not realising this he jumped down from the final step to the ground causing lacerations.

Emerging Issues

- Seems to be a 'manufacturing' issue.
- Not much attention had been made re-human contact with the equipment (foot placement possibly, but certainly very little on handholds)
- Accident accepted as 'one of those things' as seen by IP as not really specific to construction – no consideration by anyone that the equipment design may be a contributory fault
- ... It is common site policy to 'ban jewellery' but I reckon that it is rarely enforced (a bit like the speed limit on motorways - it is a cop out though in the end)
- SC action was to circulate a memo to all personnel reminding them that wearing of any jewellery is forbidden – each operative had to countersign and return.
- Also an issue for Tool Box talks re jewellery?

Case study	**07**		
Construction type	Residential	**IP Role**	Floor layer
Construction phase	??	**Employer status**	SC
Timeliness	??		

Accident description

IP was working at the side of the road behind his van. With a knife he was cutting out the opening for a toilet pan from 4mm ply-wood. Ply is supplied as a 1.2m x 2.1m board He normally stands and makes the cut to one side, but on this occasion he stood behind the direction of the blade. When blade came out it continued to travel and went into his leg.

Emerging Issues

- This seems to be a case of use of an inappropriate method/tool.
- Tool is bare steel – looks a pretty slippery surface (grasp and handling force?). IP chooses this tool especially for the blade stability and the need for this is an indication of what is necessary for the task. IP also happy about the way the tool fits into the palm of his hand.
- Does tool manufacturer recommend knife is used for this purpose?
- Alternative tool designs for this task?
- Change of technique – IP could not really describe why he had altered his technique for this particular cut, but had indicated that he was probably rushing and that's what caused it
- A cut to the side (apparently normal technique) would have quite a high asymmetrical loading - standing behind the blade would offer more control whilst making the cut.
- The blade, having just been changed, must have been at its most efficient. As blades are changed regularly they must be of a constantly changing efficiency during their use – therefore quite difficult to anticipate how much force to apply to each cut.
- Working in the road – in this case, offered a flat surface & he was not interrupted. Unsure of arrangements during busier traffic
- Were contractors happy with method used? If yes, does this extend to their H&S people?
- If they frown upon cutting holes this way, had this ever been communicated to site manager?
- IP doesn't ever seem to have received any formal training. Why hadn't IP had a tool box talk on this site?

Case study	**08**		
Construction type	Residential	**IP Role**	Concrete labourer
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

A concrete labourer was connecting pipes to extend a concrete pouring operation. The pipes push together and then a rubber seal and clip are applied over the join. He had trouble compressing the clip, so was using his foot to try and secure it. For additional force he hit against his foot with a scaffold pipe and hurt it! IP was very embarrassed about this and had told the Safety Advisor that the foot injury was sustained by something in the area of the clip piercing his boot.

Emerging Issues

- Language problems made this a very long interview and some issues were only vaguely understood.
- Time pressure from both concrete setting rate and from need to move lorry
- Some contradiction in whether the work is arranged by the supervisor of whether the rest of the group get involved
- Supervisor reportedly present at time – not clear if he saw what happened
- Was the accident story concocted just for the Safety Officer, or for all?
- IP had no knowledge of procedures –site induction / training?
- Comment from 'expert': 'Being a bit of a concreting expert myself, I'm not surprised clips get stiff due to concrete adhering. Once it even begins to set, it's a real *** to get off'.
- Design of system – (equipment manufacturer/supplier)
  a) are clip/pipe manufacturers aware of the problem? Do they offer anything better? If not why not? If yes, are there obstacles to the better connectors being used on site?
  b) what are the designer expectations of the site pipe fitting process?
  c) what sort of loads are the operators expected to apply?
  d) what maintenance is expected of the site fitters/mechanics - is the equipment expected to be clean (spotless) to function correctly?
  e) what guidance is given in supplier literature?
  f) if guidance is given, how does this get accommodated in training or other?
  g) what happens about user instruction?
- Equipment maintenance (site/head office/plant hirer - plant department manager or supervisor of plant fitters):
  a) what is done to ensure that pipe fittings are clean enough to function correctly?
  b) what inspections are carried out to repair/scrap damaged fittings?
  c) what contingency provision is made for spare fittings, so that they are available as replacements in case of difficulty with ones being used?
  d) what site provision is made for easy cleaning of pipe clips etc.? - e.g. was a high pressure water or air hose available to the operatives?
- Other issue is responsibility for housekeeping/maintenance on site. Who responsible for this? Why hadn't they picked up on this problem?

Case study 09

Construction type	Residential	**IP Role**	Formworker
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP was cutting the steel banding of a bundle of plywood, using a pair of nips. He cut first from one side and then the other, and although he thought he was standing out of the way, the steel band flew back and cut his arm. Resulting in hospital A&E. Returned to work the following day.

Emerging Issues

- Supervisor not aware that IP had used nips and not claw hammer to make break
- Contracts Mgr (also responsible for safety) didn't know about the accident
- Do the safety advisors recognise the hazard? If not why not (attitude/training issues)?
- If hazard appreciated, what have the tried to do about it?
- Other tie method (using nylon) is available and in spite of everyone's knowledge about hazards in this task ply is still secured together in this manner
- Why hasn't supplier used a safer alternative to steel banding? As well as springing back when cut, it also forms a hazard when lying around or being folded up for disposal. Difficulty with disposal means it is likely to be left lying around for longer (fall hazard).
- Although it would seem that a better cutting tool is available, the cut hazard remains even after the break is made.
- S/C no opportunity to contribute to the Safety Committee – Site S.O. noted that these meetings are held every 2weeks - communication issue
- Supervisor thinks Safety person visits every 2 weeks – actually he's been there full time for the past month
- Indication of time pressure affecting the atmosphere on site – all experience it in different ways
- Concern by supervisor about trying to see what lads are doing – thinks trades are worse nowadays
- Some mixed messages about who prepares the MS's – indicating communication not effective for these
- Also indication by Supervisor that MS's need to be followed only if new task type to do
- Method of transferring the RA/ MS info (wall display) seems a little uninviting
- Site based staff perceive little value in induction
- Training for all is distant and little / nil related to H&S (in spite of job responsibilities)

Case study 10

Construction type	Residential	**IP Role**	Formworker
Construction phase	Middle	**Employer status**	SC
Timeliness	Ahead		

Accident description
Operatives were on level one striking out shuttering from a hole next to a column. They knew that the formwork would drop a single level and as per procedures they cordoned off the area below. The area directly below was of the same design, but the shuttering to the hole had already been knocked out and a board placed had been placed over the gap. As the formwork was knocked out if fell down onto the board on the ground level, went straight through it and landed in the basement. Two brickies and the S.O were 1m away from the falling debris in the

basement (brickie sustained a slight scratch as the boarding dropped flat to the floor, but this has been recorded as a dangerous occurrence)

Emerging Issues

- Risk of ply cover damage not anticipated in the risk assessment – procedures had been followed
- Risk assessment - would this have been judged adequate (without our benefit of hindsight)?
- The RA and MS had been done, but not in the level of detail to identify the risk of the ply cover breaking. There is a case for a generic assessment to cover the standard issue of protection of holes through floors. However, these may be so numerous and extensive, to cover the required level of detail, that they would simply gather dust. This sort of information would be best dealt with through training, both basic site craft training and refresher training such as TBTs, where the possibility of a hole cover (normally a plywood sheet) breaking under a falling load could be raised. It could also be a standard issue raised, where appropriate, at weekly short-term planning meetings, where an updated, detailed RA can be carried out.
- Need generic MS
- Why were changes to procedure not been written into the MS? – does this reflect a lack of priority OR are written methods a formality superseded in reality by verbal communications?
- Unlikely that it could have been 'designed out' by the design engineer, although there are alternative methods of construction, such as lift slab (forming the floor slab at ground level and jacking it up into position). This would be a very big change to deal with a fairly small risk, and brings its own risks anyway.
- Permanent formwork (i.e. formwork left in to form a permanent facing to the hole edge) may have been feasible – may be costly and may have other problems in the installation of the services passing through the hole.
- It seems that a plywood sheet was provided and a batten (presumably to support the sheet half way along) was nailed on. It would take a very competent engineer to calculate whether this was sufficient to take a falling load; so the only way to ensure that such protection is adequate is to provide a protective cover to the hole that is so strong that it could not possibly fail, and so well fixed in position that it could not possibly move (bounce) away when struck.
- Ply 'lying around' is used for covering holes - is it quality assessed?
- Specification dimensions to cover openings – do they exist? S.O. did not appear to consider ply board dimensions as a hazard in the accident
- Some conflict in roles – as a Construction Management contract the roles of S.O. / Supervisor lack clarity

Case study 11

Construction type	Civil Engineering	**IP Role**	Driver
Construction phase		**Employer status**	SC
Timeliness			

Accident description
A 'Hiab'[9] delivery driver was delivering scaffold poles to a site. As he was trying to manoeuvre the load towards the drop zone the lorry tipped over (no damage caused). The stabiliser feet (outriggers) had been put down to the ground, but had not been extended beyond either side of the lorry beforehand.

Emerging Issues

- Restricted area for lorry to park – inadequate space for driver to move forward for preferred parking position – permanent works layout design implications?.
- Driver then tried to manipulate the load to the drop point without passing it over walkway – the foreman was there, but how could he stop pedestrians from each direction?
- The opinion is that multiple manoeuvres of load made the lorry less stable – Outrigger presumed unnecessary if just a single movement?
- One wheel also on railway sleepers – possibly contributory to topple?
- Neither safety devices were relevant to the accident-causing conditions
- Driver couldn't see foreman? - possible impact on accident
- Driver felt work area and access was tight, but continued with the job in any case? Manual extension of rigger relevant?
- Crane controls (as described) appear to contradict population stereotype of lever operations (ie up means down)
- No perception of 'time pressure'
- Accident occurred at 13.30 – no indication of lunch / break in last 3hrs
- Very long working hours for driver with indication of pressure to do overtime and to breach HGV driver rest allowances
- Perception of opportunities to communicate/contribute perceived very differently by interviewees - Site safety culture not perceived very highly
- Driver quite unhappy overall with work conditions
- Not really sure if there was a MS / RA. Plenty of documentation available, but not much distinction within this. Driver unaware of any written materials
- High reliance on own core skills. Refresher training up to date.

Case study 12

Construction type	Residential	**IP Role**	Chain boy
Construction phase	Middle	**Employer status**	PC
Timeliness	Late		

Accident description
Concrete-pump pipes were being blown through (a wet foam ball is placed inside the pipe and with pressurised air propelled to other end) at the end of the workday. The accident report states that an operative was standing over the pipe (at the exit end) and that with the force of propulsion as the last of the concrete and wet ball came through, this threw him backwards (onto a column). He sustained a groin and back injury & was off sick for a week.

[9] *The 'Hiab' term was used by the interviewees in this accident study as a generic term to describe self-unloading lorries – The lorry may not have had a off-loading device manufactured by Hiab.*

Emerging Issues

- Experienced operatives not available for task – indication of an ongoing problem
- Inexperienced operative undertaking task and 2nd operative not undertaking normal task
- Is it usual to have 2 people doing the operation? Did they distract each other?
- Each person has given quite a different account of the accident - reluctant to 'grass' on each other to the safety officer?
- Men at ground level seem to have given the OK with the pipe when it was a full container – transfer to empty seemed to be an afterthought - Mixed story re whether man at top requested permission to blow down or called out to them that he was doing it
- Seems that there was a fairly explosive response at the bottom of the pipe, not expected or previously seen by even the more experienced operative.
- Would the pipe fixed to the floor really resolve the whiplash action? – Could the pipe break and cause even more potential damage?
- Indication of restricted work area
- Possibility of 'time issues' – trying to finish for the day, 'Bobcat' driver waiting, not fluent at doing these tasks.
- IP's poor attitude to PPE? Relevant in considering his attitude towards risk / safety
- Long hours of all concerned - IP at work 5hrs with no break
- IP felt his co-worker was inexperienced? Was he right or wrong to try to move the pipe (if this was the case) – lack of teamwork /co-ordination may also be a factor.
- IP indicated that there is just one-way to do things right? How receptive to new ideas.
- Concrete takes priority and this seems to be reflected in work breaks and pressure upon operatives to perform
- Nobody on site was able to provide training for this task – is this usual for an activity undertaken daily
- Foreman does site safety work –Doesn't seem to like the weekly safety inspection

Case study	**13**		
Construction type	Major Building	**IP Role**	Carpenter
Construction phase		**Employer status**	SC
Timeliness	On time		

Accident description

Using a drill with a screwdriver bit on it, the IP 'lost concentration' and screwed through wood and into left forefinger. Operative was putting up a new doorway in the walkway leading to the canteen entrance. He was trying to get the work done before the men started to turn up for their break (imminent). Some men already wanted to come by and as he had to twist to move aside for them he drilled into his finger by accident

Emerging Issues

- Accident area is quite a busy stretch and if people had turned up before 10.00 am it would have become very congested
- Does the absence of a flex make the task acceptably less risky- and not to cordon off the work area?
- Safety officer doesn't have a lot of knowledge about task (i.e. roof work and step ladder), but has made recommendations nonetheless
- Interesting comments about IP's undertaking of overtime- feels he doesn't really need to do so much OT now, but has just got used to doing it.

Case study	**14**		
Construction type	Major Building	**IP Role**	Partitioning
Construction phase	Middle	**Employer status**	SSC
Timeliness	Late		

Accident description
Cutting cord on sash window, cutting towards self and stabbed self in left finger (touched bone), using a Stanley[10] knife.

Emerging Issues

- Repetitiveness of task
- Ops not changing knife blades regularly enough – (from foreman)
- Apparently no MS and RA
- Little safety training, No TBT
- Working with labourer, on steps, alternative way of carrying out task?
- Was Stanley knife was correct tool for the job? This points the finger at the method statement and risk assessment. Given this was a task with some risk, why hadn't this been picked up? Given use of knife, should he have been wearing gloves?
- Could the window not have been securely propped, to ease the difficulty of holding it and allow easier access to the point of task operation?
- Training for operatives and supervisors? - to see whether there could/should be general training in having work pieces securely held/supported etc. before beginning the task.
- MS's/RAs/Short-term planning and safety RA associated with this activity? Could/should this type of awkward task be considered, in detail, and advice given on provision and use of appropriate temporary support and safe working method?

Case study	**15**		
Construction type	Major Building Demolition	**IP Role**	Partitioning
Construction phase	Middle	**Employer status**	SSC
Timeliness	Late		

Accident description
Hand cut when removing a concrete slab from wall when dropped, initially thought to be a lintel, then found to be part of old floor.

Emerging Issues

- Limited time to plan task
- Inadequately trained personnel assisting (2nd labourer was not available for interview)
- Work area unsuitable, ground uneven, awkward for reach
- No gloves available, when gloves available considered inadequate
- Expected to be lintel, was actually part of old concrete floor
- Lifting heavy lintel, unexpected load
- Inadequate safety training, no TBT
- MS and RA?
- Lack of reconnaissance prior to starting the work, ie they didn't know what they were dealing with, possibly due to time pressures. What does the company do to ensure adequate time is allowed for work tasks?

[10] *Not necessarily manufactured by 'Stanley' – term used to describe generic knife with retractable blade.*

- Problems with the PPE - perhaps also ties in with 014. Why do the glove manufacturers supply such poor gloves? What have the eye protection suppliers done to stop them misting up?
- In demolition or renovation it is often impossible to plan the detailed procedure weeks, or even the day before. It is possible for operatives, however, to reflect on exactly how they are going to function, as a team, when the task is before them. Was there any training to do this?
- Was lifting equipment or small plant (FLT, JCB) available and could it have been used?
- It is possible, though unlikely, that the designer (architect) could have provided information that this was part of a floor, rather than a (presumably) lighter lintel. If so this should be made clear in the drawings or specification of the project, and the information have been provided to the site engineers, supervisor and gang.

Case study	**16**		
Construction type	Major Building	**IP Role**	Partitioning
Construction phase	Middle	**Employer status**	SSC
Timeliness	Late		

Accident description
Taking measurement on ceiling within building, steps gave way and fell straight to floor, injured upper body, bad grazing on both legs and left elbow.

Emerging Issues
- Step ladders failed, twisted, operative fell - Difficult to comment on suitability as not able to inspect step ladders – Step ladders have a bad reputation.
- At first sight, this seems a very straightforward equipment failure, through poor design and/or manufacture or misuse. Were the steps the most appropriate ones to use for this job? If not, then why were they selected? Who/what had input or influence with respect to this?
- Is this method of measuring a floor to ceiling distance is necessary? Are there tape (or measuring rod) designs which make it easy to measure the height, without leaving the floor? If not, a) why not? or b) could a rod be designed and made (on site, if necessary) which would attach to the zero end of the tape to allow it to be raised to the ceiling. Given that the task is done "every day, all day", it would seem to offer significant time savings as well.
- What about providing a temporary staging at a height that puts the ceiling within reach?
- It is not clear whether the measurement being taken is to an existing ceiling, prior to fixing a new (suspended?) ceiling, or to the new ceiling. If the latter, there is also the question of product design. Is there a way of manufacturing the product so that it can be levelled or adjusted from the floor, assuming that this was the purpose of the measurement?
- Apparently no MS ad RA
- Limited safety training

Case study	**17**		
Construction type	Residential	**IP Role**	Scaffolding
Construction phase	Middle	**Employer status**	SSC
Timeliness	On time		

Accident description
An operative was carrying 4 brick guards in each hand. As walking along he stepped onto an electrical cable, slipped and twisted his ankle.

Emerging Issues
- No risk assessment for power lines
- Tolerance of power lines strewn over floor – is it possible/feasible to raise them as suggested or is there another measure?
- Indication of earlier problems with the state of the floors
- IP was not overly happy there and felt isolated. Not helped by communication problems with his supervisor
- IP was dissatisfied with his 'trainee' status – perceives it as labouring work with sporadic instruction.
- Tool box talks do not seem to be acknowledged as training – all that is acknowledged is 'sit down training'
- Different perception of lifting training – safety officer sees it 'covered' in induction, IP noted only being lent a booklet
- Indication of inadequate carrying time therefore a high dependence upon manual handling on site
- H&S responsibilities of supervisor not explicit in contract and his appraisal appears to be based on failures (accident book)
- Supervisors perception of fault for accident –ownership /blame
- Supervisor states safety not compromised by encouraging work pace among the men as 'regulations are still in place' (belt and braces approach) – then goes on to say that 'safety' has compromised earning potential. Some conflict here.
- Indication of lack of patience & entrenched ideas among older men as co-workers

Case study	**18**		
Construction type	Residential	**IP Role**	Scaffolding
Construction phase	Middle	**Employer status**	SSC
Timeliness	On time		

Accident description
IP was erecting scaffold on a cantilever over the canal and caught right arm on a nail protruding from the concrete leaving a puncture wound on right forearm

Emerging Issues
- Extruding nails from concrete is an ongoing site problem
- Issues about beam weight, working alone etc. that are supplementary to this accident
- Sunlight distraction / glare at time of accident
- Supervisor distracted him – insight into task requirements?
- Scaffold solutions (to avoid working directly on tube) seem to be more trouble than they're worth?
- Scaffold fitting maintenance appears very important? Time pressure responsible for extruding nails not being knocked off
- Inadequate PPE - No training in PPE use / care Harness dissatisfaction and mistrust
- 11- 12 hr day for IP
- No procedures / instructions
- Dissatisfaction with inductions
- IP aware of responsibilities in job, but seems to feel powerless in some situations

Case study 19

Construction type	Residential	**IP Role**	Labourer
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP was moving falsework tower. He failed to remove a cantilever prop at the top and it became dislodged during the operation and fell 3m hitting the IP on the left side of his back.

Emerging Issues

- How could cantilever have become dislodged and fallen? Previously dislodged before trying to relocate the frame – if so how and was it ever properly inserted into the mainframe groove in the first place?
- No apparent procedure for this activity – should there be?
- Frames required earlier than expected? Relevant to accident. An unplanned activity.
- IP had no training in doing this task or in use and care of PPE
- IP had poor English – does this influence training / communication etc provided? - policy on language/cultural issues etc?
- Site training heavily dependent on tool box talks perceived as training by IP
- IP's work is reactive to instruction by supervisor – little perception of 'consultation' by IP, but supervisor thinks they do
- Competence assessment of new starters a bit unregulated
- Project manager has no specified / appraisable H&S responsibilities in his contract. Performance dependent upon 'force' of safety officer
- IP had a similar accident some months ago – but didn't change his practice.
- Falsework would have been a 'trade-mark' propriety system c/w catalogue and assembly/striking instructions – what info is provided?

Case study 20

Construction type	Residential	**IP Role**	Cutting gas pipe
Construction phase	End	**Employer status**	PC
Timeliness	Behind		

Accident description
An operative was removing what he mistakenly believed to be a redundant gas main from an under-stairs cupboard during the restoration of a group of housing association properties. He used a petrol saw and this resulted in a 1m flame and burns to under stairs and plasterboard. No explosion.

Emerging Issues

- Muddled story re which houses were still live and which weren't – poor communication with power company
- Power company record and notification system not overly clear
- Indication that records, if on site, were not clear. Relatively new General Foreman – why did he think supply was halted the previous month?
- Task was unplanned/ scheduled – just did it because they could carry on? Would gas records have been rechecked if this had been a planned task, or would they still have been wrong anyway?
- No training by IP in use of saw – not realised by foreman / S.O. - or is training just required to change the blade?

- Large heavy tool for a relatively small task in awkward conditions - alternatives available?
- No use of gloves /goggles for task - ? HAVS risk or possibility of particle release during cut
- Supplies own boots – should be provided. Rest of PPE sounds a bit minimal
- Arrangements for setting up a gang and liaison for safety / Union consultation – all reactive
- Training courses - seen as method to comply with H&S rules rather than as a skill transfer (by Foreman) – 'boring'
- Job & finish used to motivate speed, but speed not seen as a possible safety compromiser
- Priced work & need to finish seems to influence competitive element and time pressure
- Process of inductions / task training / TBTs seems to have been overlooked / not perceived as occurring
- Indication that housing has lower safety 'level' nationally
- Fairly low morale among site based interviewees
- Risk assessment / training issue (of both operative and site manager). Gas is dangerous, so working with gas pipe work obviously something that should be risk assessed. Also, it seems complacent of the operative and site manager to be happy to proceed solely on the basis of paperwork when the site manager himself indicated the long history of problems with the 'gas board'. What training had these guys received? What was the PC/SC's attitude to training?
- What processes can be used to find out if a gas pipe is live? - would a gas engineer working for a specialist sub-contractor, or the main contractor, could carry out any of these tests on site before the particular pipe, or group of pipes, is removed (even a non-specialist engineer?)
- Not covered in any of the MS, RA, short-term plans, Safety Plans.
- What generic procedures exist that would have picked up the necessity to treat potentially live mains, gas or electric, as serious risks?
- Was this issue recognised in the early CDM documentation, safety plans/safety file etc.
- What training is given (courses, induction, TBTs) covering specific procedures for dealing with potentially live mains. Given the risk some sort of double checking, fail safe procedures, embracing the power company, main contractor or both. There clearly needs to be a rigorous signing off or permit-to-work procedure.
- What general management and safety training is given to combat the low safety culture here, and what have the people on this site received?

Case study	**21**		
Construction type	Rail	**IP Role**	Management
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

A senior supervisory manager was climbing a rail wagon to see whether contents were fit to leave the site. A piece of wire was hanging over the top edge and he wanted to see if he could push it back in. As he climbed up the wagon he put his hand onto the top rim of the wagon (to haul himself up high enough) and inadvertently caught his hand onto a 9 x 3cm metal slither, which pierced his thumb. It is thought that the slither is likely to have been generated from damage by a digger as it loads the wagons.

Emerging Issues

- No device to look into wagon without climbing up the side
- Side ladder and handrail arrangements doesn't seem to facilitate usability
- Little confidence in contract labour
- Time pressure- does it need to be like this or has it become the accepted norm?
- Time pressure encourages undertaking of unusual activities by supervisory / management staff
- Was consideration of human interaction considered during wagon redesign – Are viewing, handhold and foot placement areas designed or ad hoc and just where they happen to fit on?
- Excessive working hours and infrequent days off – but impression that this is self-generated and he cant stop
- Task commonly undertaken, but excluded from method statement or risk assessment
- If people need to get up to the top of the wagon (and inside as the notes suggest), then provision for this should be designed into the wagons.
- Why wasn't the wagon rim sufficiently robust to take foreseeable wear and tear. Who makes these things? Who buys them? What attention to they give to human factors aspects? Point that ladder provision on wagons is being improved is noted.

Case study	**22**		
Construction type	MB Refurbishment	**IP Role**	Ceiling fixer
Construction phase		**Employer status**	SC
Timeliness	On time		

Accident description

Whilst removing plaster board from a trolley the persons hand was crushed against a scaffold tube hand rail.

Emerging Issues

- Recorded accident cause does not closely reflect events described by IP
- H&S Manager speculation of 'cause' very blame orientated
- IP had been reluctant to cite the communication problem for fear of being accused of being racist
- Scaffold design – Is it best practice for the clips to be positioned like this and to be uncapped?
- Remedial action seen as PC responsibility by SC – indication of lack of communal ownership in safety management
- Unclear whether pushing plaster trolley is ceiling fixers job or not – IP only one who thought not
- Is reluctance to push trolley a status issue or is it not actually scheduled into work in progress
- Plaster trolley seen as helpful - comparative competitor product for the job & design variation?
- No one seems to have considered that the trolley might be an aspect in this accident
- One man down on accident day – issue to IP, but not noted by others
- Decisions / opinions of competency seem to be repeatedly conferred to 'a.n.other' (previous experience of a company, responsibility of men to supervise labourers). What do we know of the skill & ability of the person making these decisions & do they realise how their decisions impact others

- Try to use certificated schemes for competency too, but need for labour seems to be an over-riding factor
- 'Don't discuss safety unless get hurt'!!
- Indication of low level consultation in work organisation – liaise on a job by job basis only
- Perceived difference in how internal / external H&S people assess safety with internal appraisal seen as less judgemental OR this might also reflect level of safety training too?
- Site Mgr saw supervision as a responsibility of PC – PC (H&S Mgr) described supervision as a SC issue.
- Dissatisfaction with welfare facilities
- No RA for product transport on site
- Mixed story re. training in plaster trolley transport –(IP no, Site Mgr –yes)
- Very long hours by H&S Manager + long travel time by him & Site Mgr
- Skill training for ceiling fixer seems a bit ad hoc – 'sitting with Nellie' for an unspecified period of time
- Little in way of short courses for SC personnel
- No specific safety training for any of these men
- TBT perceived by IP as a stick wielding exercise, yet desire for formal training is there
- IP young and suffering long term back injury – no sickness absence pay. Employer aware - no construction assistance

Case study	**23**		
Construction type	MB Refurbishment	**IP Role**	Ductworker
Construction phase	??	**Employer status**	SC
Timeliness	On time		

Accident description
IP was descending the stairs carrying a toolbox. He slipped on an oil patch which had been covered with paper resulting in a bruised elbow & hip.

Emerging Issues
- Recorded accident cause does not reflect events described by IP- paper or plastic oil covering described by Foreman / H&S Mgr
- Was there a pipe fitting machine with an unsealed oil reservoir or not? If so, would it be better to seal the oil tank rather than introduce yet more guidance on a work technique.
- Incorrect action was taken after oil spill –what inhibited correct action?
- Complaint re non-user friendliness of PPE
- Alternative helmet designs available - criteria for selecting these?
- Foreman determines competency by work performance – no impression of using any criteria prior to being exposed to 'a risk'
- First-aid training seen as 'safety rep' activity
- Can 99% of people get on with everyone ?? optimistic or reality
- Impression that IP works largely unsupervised
- Indication of genuine need for formal training in this trade
- Perceived difference in how internal / external H&S people assess safety with internal appraisal seen as less judgemental OR this might also reflect level of safety training too.
- Job and finish w/end only (nobody watching work methods?)
- Safety seen by Foreman as an Operative responsibility

- Does poor planning encourage different contractor teams to make haste to obtain access to install different services? Is this particular to refurbishment?
- Safety culture viewed by IP as good 'when unnecessary safety is cut' – frequent impression that safety is OTT
- IP welcomed opportunity to discuss concerns that he has about the industry (safety culture comments)
- Minimal formal training by both Main SC personnel
- No specific safety training for any of these men
- Induction and TBTs relied on heavily as a training method to ensure compliance with site rules / plan – induction though not really seen as valued by either Main SC personnel
- Dissatisfaction with welfare facilities
- Very long hours by H&S Manager + long travel time by H&S & Site Mgr
- Indication of significant work related health problems among duct worker – not apparently being managed.

Case study	**24**		
Construction type	MB Refurbishment	**IP Role**	Fitters mate
Construction phase		**Employer status**	SC
Timeliness	On time		

Accident description
IP was cutting a threaded rod out of the ceiling. Hacksaw slipped out of hand and sliced through top of left thumb above nail resulting in a cut.

Emerging Issues
- IP indicated that he had been trained to use a hacksaw, but not technique to cut off the stud.
- Others attributed accident to carelessness / negligence by IP, but he had never been shown correct technique and indicated that all colleagues worked in same manner
- Alternative and safer technique was known but this had not been communicated until the accident event.
- Task considered a basic trade activity – indication that when considered 'basic' or 'trade' it is incumbent upon operative / Fitter to oversee work practice – these are the baseline skills that they are expected to have
- IP seen as a skilled fitter - awkward phase being towards end of supervisory period but not finally 'approved'
- Indication of tolerance of poor housekeeping
- Accident late in day – possible fatigue issues
- High dependence on inductions & TBTs to ensure compliance with site rules / plan
- Indication of low level of consultation in work organisation , but TBTs give feeling of involvement in safety related issues
- Minimal formal training by both Main and SC personnel
- No specific safety training for any of these men
- Induction and TBTs relied on heavily as a training method – but not perceived by IP as 'training'
- Is there a design alternative to using this approach (over-length threaded stud cut to length after installation. Is it usually in TBT's; MS? Could a special tool be developed?

Case study 25

Construction type	Major Building	**IP Role**	Surveyor
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

'Climbing down external scaffolding and a piece of roofing material cut the back of my hamstring'. (Quote form accident report). NB: Roofing company had since left site with the impression that they would not be appointed again.

Emerging Issues

- Project Mgr didn't know about accident
- Housekeeping issues related to the roof company working under time pressure / delay?
- Does sole occupancy of a work area by an SC offer some endorsement of 'own rules' storage / space use (Regularly tolerated on sites?)
- Accident reported to Site Mgr and not (apparently) the roofing company - feedback failure
- Young employee with high safety motivation, but feels there is lack of interest among his seniors and his concerns seem to be ignored
- No apparent avenue for young employee to apply and perhaps take some leadership with his knowledge and enthusiasm
- Project Mgr appears torn with time pressure and the need to keep accident levels down.
- Effectiveness of communication between Site and Project Mgr? - OR was there an informal / unregulated standard of safety / housekeeping that is taken as 'norm' but which is out with the best practice that the IP would have learnt.
- Interesting comment about small scaffold aperture between level change – any formal criteria for this?
- Seems as if the project design was constantly up in the air – 'too many cooks' (Architects / client /tenant)
- Financial compensation for work acceleration – presumably project work plan evolving day by day. Also ?? is there an issue of site size – is there ever a limit as to how many people can be working on one area at a time (per m2).
- Criteria for apportioning extra time to a project questioned – how would 6½ weeks be identified as the right time (ie. Does it include undoing of work completed or is it just the time to redo the new requirements assuming a 'blank canvas' prep?
- IP no training in use c/o PPE
- IP expected a fleece to be provided – is this PPE and how do people generate their expectations?
- At least 11hr day for each employee. OT taken for granted? Taken as read that it will be provided & that breaks will be worked through - culture
- IP experienced supervision problems – clash with one of them
- Project Mgr performance monitored by re-active (rather than active monitoring)
- Client pressure upon work schedule – Project Mgr trying to juggle with this and worries of operative fatigue etc..
- IP – no safety related training on degree course
- Emphasis on gaining signature in site induction - paperwork orientated
- First –aid seen as 'safety training'
- Was anyone clearly identified as responsible for housekeeping on the site, either within the PC or SC? If so, did they acknowledge this responsibility? Why was HK neglected?
- Problems with the quality of work of the roofing SC.

- Given the IP was photographing defective works by the SC and the injury arose from their materials, this doesn't give a good impression of the subcontractor. .So how did the PC come to appoint a 'cowboy' roofer? What are their procedures for assessing 'quality' when appointing SC's? Whatever these are, it sounds like they failed on this occasion. Why?
- IP recorded housekeeping as "poor" with "debris and materials lying around". Although there seems to be an effort to blame the SC, generally SCs will follow the general example set by the rest of the site, particularly if it is poor. There is a wider issue of general safety culture, which also seems poor, based on the total lack of support to the IP, when he tried to raise safety issues.
- There is mention of a £100 'prize' for the best SC each month - how was this measured and how objective did the SCs consider it to be? Was it just a sop to management who wanted to think that they had a good safety culture?
- There is also the issue of time pressures, penalties, >1000 AIs (Architects Instructions), habitual overtime etc. Were the client/architect (or the MC, for that matter) aware of the consequences for safety of this sort of project management; had they considered this issue in any RA?

Case study 26

Construction type	Rail	**IP Role**	Sheet piling
Construction phase		**Employer status**	SC
Timeliness	On time		

Accident description
Whilst knocking in a sheet pile with a sledge hammer, he missed which resulted in him pulling a muscle in his back

Emerging Issues
- Rushing slightly to get job done
- Difficult to do with machinery because of trackside location
- Hot day
- No task training
- Was taken off another job to help complete this job
- Task carried out regularly
- Back injury wasn't apparent straight away until after IP had driven home
- Although assured of safety on rail, section engineer hadn't done any safety related training until recently.
- Did MS actually cover manual installation

Case study 27

Construction type	Civil Engineering	**IP Role**	Safety controller
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
While bending down to pick coat up hard hat fell off. Operative picked it up and as he stood up he hit his head on the stanchion and sustained a cut.

Emerging Issues

- Possibly a combination of badly designed hard hat (which is a constant complaint for all sorts of reasons) or carelessly worn hard hat, and, possibly, excessive haste.
- IP's hard hat 'fell off' when he bent over - Complaint re non-user friendliness of PPE, especially difficult to wear in heat.
- Who was responsible for purchasing such PPE in this case? How much thought and effort did they put into this? What do manufacturers do to ensure wearers will be comfortable (and protected)? Hard hat design issues - particularly protection against falling off, protection against improper wearing and comfort (to dissuade improper wearing);
- Although reported not to be hurrying, was trying to avoid delay in work as men are required to leave track when COSS is not supervising.
- Conflict between pressure to get job done and behaving in a considered way, particularly the way that this issue is dealt with in training - Training may well emphasise safety first, second, and last (particularly on the railways now) - but how much time is devoted to real behavioural training to reinforce a 'think before you act' culture – simply conveying the information that this sort of culture is required is not enough.
- Exposed stanchion - is this something that should have been picked up by a risk assessment? Often, protrusions are either padded or wrapped in high visibility tape, to reduce risk. Would this have been appropriate/ feasible in this case?
- Difficult area to work in, restricted space, no area for possessions.
- Underfoot conditions difficult, moving ballast.
- The physical working environment (space, footing etc.) may well be an issue but it is difficult to see how this can be designed differently, given the nature of railway work, unless work is prohibited without total line possession - an expensive possibility which would probably have repercussions for the safety of the travelling public by delaying necessary maintenance etc.
- Given restricted space, congestion and adequate supervision could be issues mitigating against safe working of large gangs, with not enough to keep them all focussed on the task in hand.
- Job entails high level of responsibility
- High risk area, risk from overhead lines, trains and high voltage cables at side of track.
- Weather changeable
- Had been working for 8 hours prior to accident.
- Very 'heavy', stringent safety culture.

Case study	**28**		
Construction type	Civil Engineering	**IP Role**	Lorry driver
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

Whilst operative was standing on the ground unloading sheets of plywood from his lorry, his glove became trapped by one of the sheets. Because of this his hand slipped out of his glove, causing him to fall backwards onto his arm, resulting in a fracture to his left wrist.

Emerging Issues

- Gloves slippery when wet - is there a better design of gloves?
- Adverse weather (rain) prolonged job and made wood wet
- Leaves on ground may have made ground slippery
- Working at dusk, reduced lighting levels
- Sometimes required to work until 19.00 to fit jobs in working day
- Unable to plan jobs, done as able to fit in
- Sometimes wood still has nails in (not a problem at time of incident) but could have been in mind of IP when handling wood
- Lack of procedures for task
- Job causes worry to IP
- Training in MH - firm grasp of item, particularly in wet, slippery conditions (both of item and floor) was not good - probably positioning of body and feet also poor - height of plywood sheet on lorry (Assume that the IP was on the ground and reaching up) also would cause a problem - Was there someone (of the other two operatives) on the lorry helping to hand down?
- Someone trained to fall properly would probably not have suffered a broken wrist - could this be included in general training?

Case study	**29**		
Construction type	Civil Engineering	**IP Role**	JCB driver
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

IP injured back whilst lifting 'forks' onto 'JCB[11]'.

Emerging Issues

- Forks very heavy
- Awkward to lift as need to support forks while lifting and lowering
- IP – no real safety training
- IP never seen MS or RA
- Feels supervisors will not act on any problems, don't listen, not receptive
- Fork lift truck would have been more appropriate for job - not available
- Issue of lorry body blocking access, appears to occur frequently
- No investigation into alternatives to having to do this task
- No task training, despite fact that foreman states TBTs have been given on manual handling many times, no task training
- IP unsure if adequate personnel, may be beneficial to have another Op to assist
- No remedial action
- Foreman felt there was nothing difficult about the task as it had been done hundreds of times before and no problems before
- Foreman reports that safety is never compromised - so accepting that this must be ok because it is done lots of times

[11] *'JCB' term used by interviewees in this accident study to describe multi-functional back-hoe excavator – The excavator may not have been manufactured by JCB.*

Case study 30

Construction type	Civil Engineering	**IP Role**	Sheet piling
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
Adjusting level of sheet pile with a sledge hammer (Not installed at correct level by machine). IP missed pile and pulled a muscle in his back.

Emerging Issues
- Similar to accident 26
- Machinery used originally to knock in sheet piles had not achieved correct height
- Hitting piles lower than foot level with sledgehammer
- Helping to complete this task, was supposed to be doing something else
- IP rushing to go to next job although indicated no time pressures
- Had been doing similar job on day before and for 1 hour before incident
- Ground unstable
- Weather warm
- Good safety culture on railway
- Was MS for the SPECIFIC activity or was it a generic machine installation MS?
- Sounds puerile but do they have specific 'training' on how to use a sledge hammer - general view seems to be 'experienced therefore okay'

Case study 31

Construction type	Civil Engineering	**IP Role**	Loading HIAB
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
Whilst placing a platform on the rear of a Hiab[12] wagon, which was in the up position, the driver who was holding the platform let go before the IP had pulled his hand clear. This resulted in his left hand being trapped below the platform. The injuries were a closed fracture of the index finger and laceration of the middle finger.

Emerging Issues
- Very awkward task
- IP was not experienced in doing this task, was helping driver
- Nothing to take hold of to pull platform up
- Extremely heavy and having to support while lock is put in to keep platform in place
- IP feels that always expected to rush but do first class job
- No safety training
- Not rushing at time of task but wagon could not be loaded until this task was completed.
- Not happy with remedial action – addition of rope handle, not satisfactory
- Not consulted regarding safety
- Feels others take risks when the 'boss' is not there to watch over them
- No MS/RA
- Good study for general issues on training/motivation/method statements etc

[12] *The 'Hiab' term was used by the interviewees in this accident study as a generic term to describe self-unloading lorries – The lorry may not have had a off-loading device manufactured by Hiab.*

Case study 32

Construction type	Major Building	**IP Role**	Concrete work
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
Moving pipes for concrete pump - pipe was full of concrete - dropped pipe on right foot.

Emerging Issues

- Awkward location of area where concrete being poured – inside building but also having to get pipe over shuttering
- Had to be completed later than other pours because of check for water tightness
- IP inexperienced, no task training
- No toolbox talks or MS/RA. Learn by doing.
- Concrete pipe heavy
- Clips difficult to remove
- Not usual job of op, will be training to be an engineer, brought onto job to get completed.
- No knowledge of MS/RA by op.
- Site engineer writes MS and RA - rarely/never read by ops.
- Thinks accident was caused by lapse in concentration
- Clips on pipes often difficult to undo, become clogged up with spillage of mortar which seeps out, unless totally clean will be difficult to take clips off.
- Paid a fixed wage so if gets work completed early can still earn full wage
- Considers there to be a clear conflict between maintaining earning potential and working safely
- Considers form of inductions inappropriate, would prefer a 'guardian' scheme

Case study 33

Construction type	Major Building	**IP Role**	Laying Kerbs
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP was laying a kerb - as he lowered the kerb he caught his 2nd finger on his right hand between the block and the stone bed cutting the tip of his finger by his fingernail'. (Quote from accident report).

Emerging Issues

- Why were the gloves provided poor? Who specified their purchase in this incident? Company purchasing manager?
- Glove design - is synthetic material selected on cost grounds - are there better gloves available, which would be less "sweaty"? Glove manufacturer? Assurance from the IP that gloves would not have protected him on this instance is questionable.
- Have the kerb manufacturers considered handling issues with respect to how they are supplied? Has anyone within IP's employer ever raised the handling of kerbs with their supplier.
- The main problem seems to be inappropriate handling, method and PPE. The sections of kerb, in this case, do not seem to be over heavy or large.

- Training in lifting and placing is an issue, perhaps to prevent people lifting 4 at a time! What expert training is available?
- This may be the sort of very general risk that does not need to be in a RA. If RAs are extended to this extent, then do they become so bulky that nobody looks at them anyway?

Case study 34

Construction type	Major Building	**IP Role**	Ductworker
Construction phase	Middle	**Employer status**	SSC
Timeliness	On time		

Accident description
IP was 'un-stacking ductwork. Pulled duct and caught (hand?) between 2 bits of duct. (Quote form accident report).

Emerging Issues
- Seems to be a function of no gloves, difficult handling, no appropriate training in general manual handling techniques and risks, possibly poor stacking, possibly inadequate consideration of handling problems during design.
- Ducting was metal (lightweight).
- IP wasn't wearing gloves. Why not? Were gloves available? Use encouraged/enforced?
- To what extent might deficiencies in site supervision have tolerated lax practices? How interested is the PC in site safety?
- Designers of ducting - what do they take into account, in relation to ease of handling, stacking, holding and fixing, during their detailed design process. Do they have any RA checklist or pro-forma to use? Do they have interaction with the erection gangs/supervision to discuss 'buildability' and handling, in particular? Do they get any feedback on site experience with their designs?
- Training in manual handling, including materials stacking/storing; and managers [as above] contacted to see why such training is not used or other provided.
- Low visibility of such accidents when compared with the cost of doing most of the above. The fact is that such accidents are frequent but the, probably quite considerable, aggregate costs go totally unrecognised. Evidence shows that productivity on an activity after disruption of more than 30 minutes is reduced, typically, by 30% for the rest of the working day - and this is only one of the possible additions to the direct cost of delay to the activity.

Case study 35

Construction type	Major Building	**IP Role**	Ductworker
Construction phase	Middle	**Employer status**	SSC
Timeliness	On time		

Accident description
'Drilling ductwork and swarf went into eye. (Quote form accident report).

Emerging Issues

- Many similarities between this incident and number 34.
- Non-use of eye protection Why? Uncomfortable? Hinders work performance (gets steamed up)? Not available on site? Poor supervision? Training/supervision/site safety culture
- Alternative method of fixing, without drilling and pop-riveting (but possibly with its own hazards) - was it considered / why not?
- Method of reducing swarf (e.g. better designed/sharper drill bits or shields on the drill itself?) What about reducing drill speed to prevent swarf being projected away from the work piece?
- Is there a way of fabricating ductwork so that jointing on site does not require ANY tools or metal fabrication? - e.g. push fit connectors – now common in plumbing with plastic pipe work
- Pre-assembly would reduce need for on-site connections.
- How do innovations or new methods of working that improve safety get communicated across the industry. What means are there for spreading the word with small changes such as the one arising here? If a mechanism does exist, why didn't it work in this case?
- Operative training, particularly unskilled/semi-skilled operatives who would be unlikely to experience any sort of 'apprenticeship', not even 'sitting by Joe' in most cases. There are probably real productivity gains to be made from expert training in handling materials, hand-tools, PPE etc, as well as from accident prevention.

Case study	**36**		
Construction type	Major Building	**IP Role**	SC
Construction phase	End	**Employer status**	Plumbing
Timeliness	Late		

Accident description

'Whilst climbing down from a mobile aluminium scaffold [the IP] banged his left elbow on the aluminium strengthener around the access / egress hatch causing a chip / fracture to the left elbow. (Quote form accident report). IP was wearing a harness that became caught on the tower.

Emerging Issues

- Human interaction – access hatch size/functionality
- Design of scaffold to avoid 'sharp' things to hit
- Harness – why was it worn? Problems with safe access – handrail not possible due to clash with ceiling and services.
- Why did harness 'snag' (big buckle at back) – harness and tower design
- Tower level & safe access – re-designed or selected to suit working height and adjacent works
- IP erected own tower – Issues of 'self-erected' access towers – training? – Risk assessment?
- IP had previously been stopped from working as had no harness on and tower handrails were not fitted – difficulties in then locating a harness
- Why was harness not mentioned in accident book?
- Concentration
- Nil remedial action – 'IP was already following all site rules'
- Pre-assembled services to reduce above ceiling work

Case study	**37**		
Construction type	Major Building	**IP Role**	SC
Construction phase	End	**Employer status**	Pipefitter
Timeliness	Late		

Accident description
'Walking through ground floor link - Knee wasn't 100% anyway, it had been giving him problems previously & the turn into the link twisted it'. (Quote form accident report). IP said he caught his foot on cables.

Emerging Issues
- Housekeeping – lighting / tidiness issues
- 3 lux lighting standard considered too dark by IP
- Cable management – cables were for power tools
- Safe access ways not in place or not enforced
- Why the discrepancy between accident book and IP version?
- IP had 'other things on his mind' – otherwise would have avoided the cables
- 'Job and knock' as no bonus scheme

Case study	**38**		
Construction type	Eng Construction	**IP Role**	Driver
Construction phase	NA	**Employer status**	PC
Timeliness	NA		

Accident description
'Whilst moving fuel bowser from one vehicle to another. Jockey wheel slide on clamp and wrenched left arm and shoulder'. (Quote form accident report).

Emerging Issues
- Inherent design inadequacy in the jockey wheel mechanism, exacerbated by the operator having received only limited safety advice for this operation. Presumably because the risk here had not been picked up by a risk assessment.
- Is the jockey wheel mechanism really standard, with no variation in either design or instructions provided, from one implementation to another? There are better implementations - why was this one used?
- How did the bowser manufacturer envisage this risk would be controlled/avoided?
- To what extent was safety a purchasing/hire criterion?
- Was the level of risk assessment undertaken sufficient in terms of coverage and detail to identify risks such as this.
- Has there been effective learning from this incident? Does the contractor have any formal mechanisms in place to advise site personnel elsewhere of such risks? Has the contractor contacted the bowser supplier to inform them there has been an incident?
- Is there (should there be) any obvious warning on the equipment? – And would it have any impact, without specific training, anyway?
- What training had the previous user (as well as the IP) had in how to handle and leave (park) the equipment?
- Could the equipment be designed with a more secure form of support, either replacement or supplementary. (Caravans have retractable, screw operated corner stays.) For example, this could not happen with a tow-bar support operating like a scissor jack. -

- What about the possibility of temporary blocks under the tow-bar, as standard practice for parked trailers?
- The bowser probably could have been parked so that it was accessible to the towing vehicle, without man-handling; but this is really asking a lot and may not have obviated the need to slacken the clamp or lift the tow-bar. It seems that there are no obvious secondary handholds on the bowser, to encourage two-person handling. The facility and training to do this may have helped.

Case study	**39**		
Construction type	Eng Construction	**IP Role**	Maintenance inspection
Construction phase	NA	**Employer status**	PC
Timeliness	NA		

Accident description
'Whilst torquing 'bolts' on a gantry - IP strained his back'. (Summarised from accident report).

Emerging Issues
- It would appear that IP would not normally do this task and had the discretion and responsibility to make this choice.
- Operation should have been subject to a more detailed MH risk assessment, according to the MHO regs (in addition to the risk assessment required under the MH&W regs). It seems this didn't happen. Why? How does the contractor comply with the requirements of the MHO regs in general?
- Is the design requirement for this task to be done at all. Are there engineering solutions that would avoid the need for this torque checking operation? If yes, why was it implemented in the way that it was?
- Absenteeism may have been a factor, i.e. the maintenance inspector mentioned 2 fitters being off sick and being behind with the work. Why hadn't replacement staff been brought in? Was the staffing level adequate? Who are the decision takers in this respect? Are they best placed to make judgements over this? Do they explicitly consider health & safety?

Case study	**40**		
Construction type	Eng Construction	**IP Role**	Laying concrete
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
'[IP] was placing concrete throughout the day and suffered burns around the ankle area. He was not wearing wellingtons at the time of the incident. Swelling and burning was noted at the end of the shift on [following day]. (Quote form accident report).

Emerging Issues
- Primary aspects are the actions and training/induction received by IP, ganger and site manager. It seems reasonable to assume that if the IP had realised the consequences, he wouldn't have stood in the concrete without adequate footwear.
- Given that concrete handling is such a common activity in construction operations, it seems fundamental that everyone, at all levels, working in the industry should receive some formal instruction in procedures and associated H&S issues. Why hadn't this IP/ganger/site manager received this? Why does the PC tolerate this?

- Who should have spotted the IP not wearing boots? Does this lie with the ganger or site manager? Were they aware of their responsibilities? Why did the supervision fail? What do the people at the top (i.e. head office managers) do to ensure procedures are in place and operate correctly? i.e. do they do anything to check up on supervisory arrangements?

Case study **41**			
Construction type	Civil Engineering	**IP Role**	Labouring
Construction phase	??	**Employer status**	SC
Timeliness	??		

Accident description
Passing vehicle caught tractor winch cable, which was positioned, across road junction. Cable came under tension, striking IP across upper leg.

Emerging Issues
- Working at junction of road
- No third person to watch for traffic
- Had signalled to start winching but not sure if was in progress
- Long hours to complete work to minimise disruption to water mains
- Lack of acknowledgement of men at work signs by public
- IP working away from home, has long journey and early rises to travel to work
- Foreman feels under stress, dislikes amount of paperwork he has to do
- No appropriate RA/MS for a potentially very dangerous activity. Any winch pulling of steel (presumably) rope can be lethal (rope under tension breaking or slipping free), if not properly organised, even without potential external interference from traffic. The whole approach to RA/MS development and dissemination, from planning office to induction/TBTs, needs tracking, to establish exactly where the system failed to get appropriate risk and method information to the operatives.
- No training of operative and foreman to recognise the generic dangers of this type of operation. Quite incredible that neither see the possibility of any remedial action. Check training plans/provision - MC and SC. No specific responsibility for keeping traffic well away from operation in progress - should be referenced in both generic and operation-specific short-term planning and, if training (what happens at road junction, when it was, presumably, essential to pull rope across live carriageway).
- The combination of performance-related pay and no formally monitored breaks also seems to be asking for trouble. Advice/instruction/training not given to Foreman on this aspect of human capability - why not?
- Could the task method have been designed to avoid the cable crossing the carriageway, for example by pulling it through the pipe from the other end?

Case study 42

Construction type	Major Building	**IP Role**	WATER MAIN REHABILITATION
Construction phase		**Employer status**	SC
Timeliness			

Accident description
IP was using a boring machine with steel flails at the end (these spin round in the main to clean mains pipes). These steel flails occasionally catch something and bend but tend to keep their spring. IP was using two fingers to put a pin in from the side - when put pin in it spun round and caught glove and dragged hand into flails. Because the rods spin they heat up and this can grip the rubber gloves.

Emerging Issues

- Rack feed borer inherently dangerous machinery to use
- Using incorrect gloves, but this was because hands get wet using correct ones
- Design of machinery, lack of guarding, although indication that guards are annoying
- IP very experienced
- Pins difficult to place/remove, changes shape as a result
- Regular tool box talks
- Pressure form 36hr programme of closure
- Very long working hours
- IP had worked night shift, only 4-4 and a half hours between shifts and 2 hour travel time so no more than 2 hours sleep.
- Have had task training
- Task has been subject of a TBT
- Site agent feels does not get enough responsibility
- Ops al directly employed
- Foreman blames operative error, repetitiveness of task, taking things for granted.
- Site agent suggests motivating ops by using pay incentives.

Case study 43

Construction type	Residential	**IP Role**	Electrician
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP began 'dressing in' armoured cable to flat, when debris lying on cable fell into face and eyes (accident book).

Emerging Issues

- Seems to revolve around debris on the cable and failure to wear eye protection. Whether the operative was drilling or not is hardly relevant, other than that instructions re. wearing eye protection may be more rigorously enforced.
- Difficult to see how debris could be eliminated? Sites are dirty places, even when housekeeping is good. It might be recommended to keep cable rolls protected until in use, and clean and straighten cable before lifting into position, as standard practice. Could this be done? How would it impact on the efficiency of the task, as well as accidents?
- Cable in a flat coil which collects dust and debris - a common occurrence

- Difficult component to work with, stiff, have to draw out and unravel
- Awkward job requires two persons, one to hold cable in tray and another to drill and fasten cleats
- With tighter specification of cable runs (and pipe runs) in new-build, to be able to define standard lengths, they could be cut to length off site and even the ends stripped for easy connection, or away from the work place. This would probably pay for itself in waste reduction, as well as changing the task method to be safer. Pre-fabricated wiring 'looms' has been standard in car manufacture for years and is also being used in construction.
- Electrical supervisor thinks IP was drilling without goggles but denied by IP
- Supervision of PPE wearing, the site rules (as specified and as enforced), any difference perhaps in advice/rules when working above eye level (i.e. beneath the task), the application of the points system (when was the last time anyone was removed from site? what do the current records show about points accumulated?)
- IP was given separate TBT on use of safety glasses/goggles when started on site as only has one eye
- Not clear if wearing hard hat at time, mentioned makes access difficult despite this being a two point offence (three points = off site)
- No task training
- Working at height, restricted space
- IP earning lot less as self-employed previously was directly employed.
- Difficulty enforcing wearing of safety glasses/ goggles
- This project requires regeneration of local unemployment but this makes it difficult to ensure quality and experience of ops
- Electrical supervisor says all ops see MS at induction and sign to say read
- Supervisor thinks too much responsibility for his pay (gets £1 an hour more than ops) – states only comes to work for the money

Case study	**44**		
Construction type	Residential	**IP Role**	Scaffolding
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
Whilst walking through site a piece of timber from upper level fell and struck the left forearm of the IP.

Emerging Issues
- May be key that he was on a pedestrian walkway so standards should have been higher
- Lots of unknowns
- Untidy housekeeping
- Unable to establish who may have dropped timber suggests poor safety culture with SCs
- IP feels too much responsibility in job
- Barriers in place where timber was thought to have dropped from
- Edge protection / debris netting etc - but pretty hard to comment without being there and seeing the situation

Case study 45

Construction type	Residential	**IP Role**	Plumber
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
While IP was soldering copper pipe, he removed glasses to scratch eye, had flux on fingers, which went into his eye.

Emerging Issues

- Not able to wear goggles, wears spectacles, hard hat with visor not available but has since been ordered.
- Appropriate PPE not available and wearing of what was available not insisted on - problem of glasses not recognised by supervisor - hard hat probably made risk worse. General problem of PPE design/ availability/training/supervision etc.
- Hard hat makes more difficult, reduces height for access
- Indicates hats with visors are available but says that goggles are not normally worn for this task.
- So many things about this accident suggest a poor safety culture – clearly NOT top priority, whatever the people concerned say. Top down leadership not evident. Training of managers, not just in what needs doing but also HOW, is required - I/P skills.
- Site manager regarded cause as carelessness
- Site manger suggests flux was on finger and wiped eye whereas op reported flux spat directly into eye.
- Plumbers should be educated /trained in using brushes for applying fluxes etc instead of using their fingers- is this a COSHH item? They need to be taught how certain substances can cause long-term health problems
- IP has had little or no training in 30 years
- Site manager had attended very few training courses.
- Not seen method statement or RA for task.
- MS in place for some time for repetitive tasks, only shown to ops if a new task.
- What should be in RA/MS? They can't cover every task or they become so large that they will never be read - they must focus on residual, out-of-the-ordinary risks; so general training, TBTs etc. must cover the common risks.
- IP experiencing ill health which he is very concerned about, has side effects from medication.
- IP enjoys working on this site, good safety culture and good welfare facilities.

Case study 46

Construction type	Civil Engineering	**IP Role**	Piling
Construction phase	Start	**Employer status**	SC
Timeliness	On time		

Accident description
IP was the driver of a crawler mounted piling rig – he was carrying out routine maintenance on his rig standing on the running boards – he pulled open a door to gain access to the machinery – the handle of the door came away in his hand and he fell (approx 1.7m) to the ground…. He landed ‘on his feet’. He had a little pain for the rest of the shift… He reported the incident because he thought that it could have been worse.

Emerging Issues

- Routine task – not really considered as a risk
- Old equipment (door handle and piling rig – commonly 10 years old or more)
- Access needs conflict with operation of plant
- IP and others reckon hand rails are not practicable
- 'Small' distance to fall therefore not seen as an issue
- Evidence of company 'ad-hoc' 'improvements to plant (addition of access steps)
- Newer plant access may actually be worse

Case study	**47**		
Construction type	Civil Engineering	**IP Role**	Piling
Construction phase	Start	**Employer status**	SC
Timeliness	On time		

Accident description

IP was installing 'bentonite' pump pipes (as part of a piling operation) as he was walking across the site he fell down a shallow hole that was submerged beneath the overall site water 'puddle' and therefore not visible – the hole surrounded a 'piezometer' which was used to measure ground-water pressure (i.e. it had to be there) but was not marked, nor cordoned-off, nor back-filled – injury was slight cut to hand and twisted knee.

Emerging Issues

- Relatively inexperienced although well educated IP
- Why did 'mate' step over the puddle & he step IN?
- Water and mud are ubiquitous on civil engineering sites – is this a 'too hard' issue? – Is it reasonable to assume that the site could have been clearer
- Basically, if the piezometer installers had back-filled the hole (as they were supposed to) then accident would not have happened
- Also if de-lineated walk paths had been identified and marked out they would not have gone over 'holes'
- No apparent 'design' (permanent works) issues here
- IP VERY positive about H&S on this site

Case study	**48**		
Construction type	Civil Engineering	**IP Role**	Labouring
Construction phase	Start	**Employer status**	SC
Timeliness	On time		

Accident description

IP had a previous shoulder injury (boxing-related) – He was installing a 'Geogrid' membrane – He pulled it and it snagged on something – and he 'pulled his shoulder out' thus aggravating the previous injury.

Accident record added: Pulled Geogrid to level – some hardcore on top – when ripple came out became slack & stumbled back – aggravated old boxing injury – right shoulder.

Emerging Issues

- Non-work injuries affecting work
- 'They want you to hurry without saying so'
- Very different views on 'pressure' from Op and Super
- Older guys have their own ways – younger guys are more safety focussed
- Manual handling over-exertion – was no training given?
- General operative not particularly motivated to do anything
- No apparent 'design' (permanent works) issues here
- Definitely a work method issue though
- Good use of worker instructions as well as MS/RA

Case study 49

Construction type	Major Building	**IP Role**	Cladding fixer
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

IP was cutting cladding panels with a jigsaw and a piece of metal went into his eye. He went to the doctor because of shard of metal went into his right eye (from accident report).

Emerging Issues

- Work position was "above eye level". Was this necessary or could the work have been better organised for ease of access?
- Why was the operative required to cut the cladding panel whilst on the scissor lift?
- Did the design require the panels to be cut? If so, why were they not cut during manufacture, or at least at ground level on the site?
- Why did the MS allow this?
- Could a guard be fitted to the jig-saw - e.g. a clear plastic screen - to allow the work piece to be seen but preventing swarf flying into face? If not, why not? Same issue featured in Accident 62.
- The IP acknowledged the fact he should have been wearing goggles for the operation, but the issue here is why does the panel need to be cut at all? But if it needs to be cut this must be done in a safe way, at ground level not off a scaffold.
- Why was eye protection not being worn - availability to hand; comfort; suitability for task; etc.?
- There had been no training with jig-saw or, it appears, with any power hand-tools.
- The risk perception seems to be very low - "no known risks with this operation". Clearly IP does not see electric powered hand-tools as potentially dangerous. Why not? - This is another training issue.

Case study 50

Construction type	Major Building	**IP Role**	Cladding
Construction phase	Middle	**Employer status**	SC
Timeliness	Late		

Accident description

'While passing a bucket full of tools (approx 20kg) from one deck of scaffold to the next lift, IP felt pain in the top right hand corner of his back. Sustained pulled back. The discomfort was too bad for IP to carry on with his work and was taken home. Injury caused by twisting when lifting bucket. (Quote form accident report).

Emerging Issues

- Restricted space and attempting an inappropriate task or action - change scaffold design to increase space might help, if feasible. Any alternative to cross-member scaffold for load bearing and people passage.
- Formal guidelines for aperture size in scaffold – rather than just being determined by size of the boards, or the width of the pavement outside - Aperture within scaffold for ladder seems inadequate even for a man on his own – let lone carrying anything
- But, even with more space, climbing a ladder with a bucket on the shoulder does not seem sensible - general work methods need review as this is a more detailed (mundane) issue than normally dealt with in MS. However, there probably should be a method statement covering the way of getting tools (beyond the odd hammer) and materials up onto the scaffold. Short-sighted approach to transport method of moving hand tools around the site.
- Bucket = ad hoc arrangement. Make do by the men – no formal method for tool movement on site e.g. what would happen if he fell with this bucket, or there was weight shift – injury potential and no protection from the contents - Foreman has not considered alternative to bucket for tool movement around the site
- IP described bucket as quite heavy. Not especially heavy when weighed in isolation, but not considered in the context of the environment or circumstances = no MH assessment
- It is certainly a training issue and should be followed up not only by TBTs but also by properly trained (in manual lifting methods) supervisors (and managers) also trained to intervene when seeing this kind of action. It is an unsafe act and should be treated as such. IP had some relevant training over two years ago but was clearly not convinced of its value. Either the training was inadequate or it is not being followed up, or both.
- Company train people themselves – time generated, although older / experienced ops (??such as IP) may join them
- Combination of low temperature, cold operative and awkward movement is a possible cause. No professional sportsman would attempt extreme movement without warming up thoroughly, first. Why should 'professional' operatives? Perhaps training in manual handling should include warm-up routines.
- Most big companies provide warm coats for salaried employees. They may 'jibe' at doing it for wage earners or sub-contractors because of cost and theft. However, some sort of, weightlifter type, back warmer/support belt might prevent a lot of this type of injury and pay for themselves. Such a garment would be seen as PPE and not very attractive to steal. Might be worth costing out and comparing with the cost of back injuries.
- Not long with this employer? Influences whether he would ask for assistance or not?
- IP describes job as very menial, doesn't feel listened to by co-workers – relevant to not challenging the method of moving the tools around the site.
- Poor environment at the time of the accident – light low.
- Long working week for all
- Time pressure generated from Supervisor
- IP not consulted about work org / safety
- SC firm not happy with housekeeping standard 'provided' by PC
- MH training not well accepted – leaflets
- IP doesn't perceive value from inductions
- IP has no lifting training with this co. – missed it - but doesn't perceive lack of training as inadequate
- IP no holiday in past year – paid in lieu
- Safety judged by co-operation with wearing the PPE

- Foreman role for safety not specified in his job description – no guidelines and no individual appraisal - no formal H&S training
- MS/RA are prepared pre-job \ no learning experience in the prep. for the people doing the work and are done by Contracts Director (What training?) & H&S people - Foreman doesn't see himself in this role

Case study	**51**		
Construction type	Major Building	**IP Role**	Electrician
Construction phase	Middle	**Employer status**	SC
Timeliness	Late		

Accident description
'IP tripped on a loose board on the floor, tried to save himself from falling and twisted his right thumb'. (Quote from accident report).

Emerging Issues
- Criteria for whether its appropriate to be using a tower around boarded area is not clear
- Impression from IP that the area would have been boarded if any members of public had been at risk, but that this care isn't taken for construction workers.
- What is the force and manoeuvrability of the tower is like
- What is the maintenance programme for the tower wheels
- Tower hire company address the erection process, but don't seem to have offered any advice about manoeuvrability – is it reasonable to try to push it over a board or not?
- Manhole covers put on after accident – could that have been done before accident task
- Manhole cover could have been on - why is this sort of procedure not in general work methods - training given- and made compulsory? Again, it is probably too general and fine detail to expect it in MS but it does come under general site housekeeping and can be monitored. It is also a purchasing and detailed, short-term planning issue - was the cover on site in time - was it available at the work location (purchasing personnel/site management)? Is there any resistance to using the cover at this stage because of possible damage and replacement cost? If so, what about supplying old covers, as temporary expedient, and moving them from site to site? General housekeeping issue, which could have contributed to the manhole not being properly protected (site management and training).
- Housekeeping – abhorred, but seen as a responsibility of the PC
- Debris on the floor – additional obstacle for manoeuvring the tower
- Brickies work seems to generate a huge amount of debris – is the management of this accommodated in the work set-up .
- Block work debris like ball bearings – a design issue?
- Very laborious procedure to go through to get another set of trades to clear up after themselves – chain of 4 telling to different people
- Lighting problems – subtle, may have been an environmental factor for the accident or just a demotivator
- Good ideas to prevent reoccurrence of the accident event (barriers) have not gone beyond the SC team – communication issue.
- Suggestion that other trades were in the area at the time – irritation not so much caused by their presence, but rather the overlap of work location requirements Disharmony with the brickies – they're dirty, don't turn up and upset their work programme.
- Safety instruction / training seems to be mainly the responsibility of the S.O? Can lead to loss of ownership issues

- Doesn't seem to be a huge amount of within team communication (new ideas) for IP
- 'Programme' is the measure for co-ordination /communication, yet simultaneously we here that the formal programme is always being challenged by circumstances such as no show of ops etc. – other method is just a walk round
- Measure of compliance with safety rules etc = use of PPE – high dependence on this measure
- Own company induction = read out
- MS/RA – usual sign and read system for ops
- Safety responsibilities informally assumed for supervisor – not managed
- IP senior and seen as 'supervisory' in the hierarchy anyway? Some loss of overseeing for these experienced people

Case study	**52**		
Construction type	Major Building	**IP Role**	Groundworker
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
The IP was hand digging for temporary water main for site use, shovel cut through rusty armour on cable and cut outer covering of copper cable causing a short. The area was surveyed with CAT machine prior to excavations starting but the cable was not located, also cable did not show on record drawings. The electricity company attended site and cable pot ended'. (Quote from accident report). Site supervisor's remedial action to the accident - called in the electricity company - they pot ended and left it alone They couldn't turn it off, as they didn't know where it came from. Had run CAT over it several times and never traced it.

Emerging Issues
- Definitely a potential fatality
- Inadequacy of below-ground services information – permanent works design implications
- Why did CAT detector not work?
- Supervisor acknowledged 'pot-ends' as a problem to trace – but was not aware if other equipment was available to trace them
- No user information regularly supplied to site with detector
- Ineffective procedures
- 'Job and knock' – did this encourage hasty progress? – Supervisor acknowledges time pressure problems although he stresses not for accident task
- Experienced operative
- Comments that RAs are a waste of time

Case study	**53**		
Construction type	Residential	**IP Role**	Pipe fitter
Construction phase	Middle	**Employer status**	SC
Timeliness	Late		

Accident description
'IP was dragging hose back towards external tap. He tripped over loose rubble and went over on right ankle. IP sustained swelling to his right ankle'. (Quote from accident report. Entry made by the injured person).

Emerging Issues

- Housekeeping is major issue here
- Site supervisor's thoughts of accident cause and remedial action – 'an untidy site' – 'it was visible and therefore up to the individual to decide whether they wanted to track across a particular part of the ground. In the corner where the work was the area was untidy. But it was an access point as this is the only water point for the site; therefore the builder is under an obligation to keep this clear. Could have reported it to the PC as it was perhaps too dodgy.'
- Indication that housekeeping is worse when things are delayed – more rubbish but also more materials not being fixed.
- Provision and location of site water supply – site visit showed that it was fairly inaccessible.
- Comments of weather effects on housekeeping – more materials lying around when people are 'rained-off'.
- Time pressure due to needed to test the pipe work to release area for ceiling fixers
- Remedial action = Area was cleaned up. No attempt to address underlying issues.

Case study 54

Construction type	Major Building	**IP Role**	Scaffolder
Construction phase	Middle	**Employer status**	PC
Timeliness	Late		

Accident description

Whilst carrying a scaffold tube the IP slipped on some ethofoam (protection for curing concrete), causing injury to his back (from accident book).

Emerging Issues

- The ethofoam should have been cleared before other trades came to the place of work.
- Is there another way of protecting the concrete rather than using "slippy" ethofoam?
- What have manufacturers done about this issue?
- Why was the temporary lighting not on? Did this prevent IP from seeing the foam?
- Who had made the decision to proceed before all 'ethofoam' removed from area of work?
- IP thought the safety culture on site was terrible - why?
- IP commented that there have been no toolbox talks – why?

Case study 55

Construction type	Major Building	**IP Role**	Scaffolder
Construction phase	Middle	**Employer status**	PC
Timeliness	Late		

Accident description

IP stepped onto scaffold boards, board toppled IP fell and hurt side (From accident book).

Emerging Issues

- There are conflicting reports with this accident - it is possible the accident didn't happen where the accident book said it did. If it did happen at the location and if the wind was that strong the IP should have not been working. This is a training and supervision issue.

- Training - manual handling - wind danger handling large panels/boards. What is normally given? - CITB? What was given to the IP on his scaffold course 3 months ago?
- The incident seems to have happened in the lift shaft. It may not seem to be a location with a high risk of wind - was this recognised in the RA? How is this being dealt with for the future? It could have, presumably, unbalanced the IP and sent him to the bottom of the shaft, in slightly different circumstances -so its not a trivial incident.
- Safety culture is recognised as "bad" - the foreman did not know how the accident had taken place and it is not clear whether it had even been recorded.
- Why is the housekeeping on the site so poor? Did this have any effect on the cause of the accident? Supervisor suggested that operative was helping labourer tidy up at time of accident.
- What are the safety policies of PC - and how are they implemented/disseminated? They don't seem to be making much impact on this site.
- Could a different design, methods of working have avoided the need for scaffolding altogether?
- Why are the operatives not shown the MS/RA for their tasks? Are the operatives consulted about the MS/RA during its production?

Case study	**56**		
Construction type	Eng Construction	**IP Role**	Labouring
Construction phase	End	**Employer status**	PC
Timeliness	On time		

Accident description
IP went to lift large vacuum cleaner which, he thought, was empty - it wasn't and the additional weight caused him to strain his back.

Emerging Issues
- This is a typical 'random' task with the potential to face an operative with unexpected, heavy or awkward lift. It is a generic problem that has dimensions of training, supervision, communication, leadership, culture. The challenge is to attack the attitudes that say that this type of accident is unavoidable; that trying to avoid it is a waste of time and money; and that to do so would be demeaning to the macho image of construction.
- Awkward area to lift load through door, load may have been unstable, vacuum contained rubble.
- No MS for task, only generic - this sort of task will not be covered in MS/RA documents or designed out under the current approach towards risk management.
- Safety advisor now works in visiting role to site, was on site full time until ~3 months ago
- Op has received training in manual handling techniques – they should have included how to lift; to check weight; how to check weight, if the object is not labelled etc.; two-person lifting tasks.
- Supervision and reinforcement of MH technique application - to ensure that they are applied. A short course is inadequate without follow-up to ensure that they become habit.
- Possible design issues for the vacuum cleaners: vac-full warnings; handle design for ease of lifting; etc.
- Job rushed, not expecting to do straight away

- Op working alone, felt it was not appropriate to ask for help but if needed would be difficult as only labourer on site - works alone much of the time, isolated as only labourer, difficult to get help

Case study 57

Construction type	Major Building	**IP Role**	Labouring
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
Whilst lifting sheet piles (with the crane), the IP trapped his hand between chain and pile. His wound was wrapped with a sterile bandage, and taken to hospital. He was wearing gloves at the time. (Adapted from accident book)

Emerging Issues
- IP asked what the study for, he then stated it is very difficult to prevent an accident an accident is what it sounds like, an accident.
- Why was the crane driver allowed to use mobile phone whilst working?
- Why was there not better communication between the operative and the driver for the lift? – Third party to communicate between the two as the driver could not see the operation due to crane location/confined working area – why had this situation occurred; what did the MS for this operation suggest?
- Why was the correct 'lift puller' not used?

Case study 58

Construction type	Major Building	**IP Role**	Scaffolding
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
Whilst repositioning scaffold boards IP stood on the end board being repositioned and fell through to ground level approx 5m causing bruising to shin and thigh and cut to nose. (From accident book)

Emerging Issues
- The scaffold was for the formwork carpenters to work off. There was a lot of complicated returns and junctions, is there a need for so many? Could the designers not have made more standard forms?
- Design issue- was there a need for the work to be done?
- Training issue- why did the scaffolder fall through??

Case study 59

Construction type	Major Building	**IP Role**	Electrician
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP was cutting a piece of trunking with a hand held hacksaw when the hacksaw jumped and the blade cut a cross my thumb.

Emerging Issues

- 12-hour day, possible lack of concentration and fatigue affecting manual control of tools - but no time of day recorded.
- PPE (gloves) would probably have avoided injury - why are they not worn?
- Could the cutting have been designed out? What about possible pre-fabrication off site, or even in a properly set up workshop on site, to allow cutting in a better environment? Are push-fit joint systems an option for this trunking?
- General lack of attention to MS and RA - might not have prevented this accident, but not good.

Case study **60**

Construction type	MB Refurbishment	**IP Role**	Ductwork removal
Construction phase	Start	**Employer status**	SC
Timeliness	On time		

Accident description

'During the renewal of overhead ductwork using Genie lift. Genie lift was thrown from under duct due to weight of duct. Struck [IP] and trapped him against plant upstand causing injury to left side badly bruised, broken skin, treated at A&E. Back at work on light duties [following day]. (Quote from accident report).

Emerging Issues

- This is a typical example of the effect of the combination of construction macho culture (get on with it - worry about the consequences when they happen) and ad hoc, unrehearsed/unpractised tasks (often occurring in activities not subject to 'learned' trade skills - particularly evident in demolition). The problem (90 degree bend hitting floor first), even if not the consequences (destabilising the 'Genie'), could easily have been foreseen. It would have needed a bit of careful, lateral thinking, before the task was started; but this needs training of operatives and/or author of method statement. The tick-box, check-list style of the manual handling form and RA is better than nothing; but how much real thought, leading to problem recognition and solving, is it likely to provoke?
- Does management positively encourage operatives and supervisors to look for and report problems?
- Are supervisors and leading-hands, TRAINED to be pro-active in problem recognition, reporting and discussion (or is "stop whinging and get on with it" the normal response)? It's all about positive reinforcement really.
- Are managers TRAINED to anticipate problems? - its all about rigorous planning.
- Are current RA formats and training in their preparation adequate?
- Rather than encourage total standardisation in risk management, it would be better to require managers and supervisors to respond to some open-ended questions (particularly for non-repetitive tasks) like: What might be the barriers to completing this task in a continuous process? (eg labour, plant and equipment, PPE, space, etc.) What are the most significant risks/problems during this task? What are you going to do about it? Who is doing what at each stage?
- It is really all part of a rigorous short-term planning process, of which safety plans are only a part and should not be seen as an end in themselves.

Case study	**61**		
Construction type	Civil Engineering	**IP Role**	Stripping cables
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
'The IP was removing redundant cables supported by brackets at high level. The brackets ahead were not securely fixed and gave way and the weight of the cables caused by the brackets collapsing proved to be too heavy to hold, it slid through his hand cutting it severely'. (Quote from accident report).

Emerging Issues

- Site supervisor's thoughts of accident cause and remedial action:
    - Accident cause = It happened on a Saturday. Taking our redundant electrical cable which was badly installed. There weren't sufficient brackets and it all fell away.
    - Remedial action = it was just a one off – one redundant cable. He didn't have gloves on - but these wouldn't have made it better or worse anyway. [Under different circumstances] the weight of the cable could have caught the glove and pulled him. It was not an everyday job. It may have been ok if there were 2, but he's keen and attempted it alone. Didn't know that he was dong the job. Didn't ask him to do it and he took it on his own back to pull it down. They had had a site induction (it wasn't part of the original contract to take the cable down) therefore extra time of 2hrs/day to take the cable down.
- Only generic MS in place – should specific measures have been taken to support the cable as it dropped
- Is the use of 'rebar' as a splint for cable repair acceptable practice? Has this been considered re the risk of injury similar to this incident (of even just snagging rebar when walking by)?

Case study	**62**		
Construction type	Major Building	**IP Role**	Pipe fitter
Construction phase	Middle	**Employer status**	SC
Timeliness	Late		

Accident description
'IP slipped on inside of scaffold, fell and twisted left knee. Mud on boots caused slip. Designated footpath was asked for in H&S meeting (Quote from accident report).

Emerging Issues.

- Cleaning of boots - facilities and training - Although it is recognised that this should be done, there is no provision for it - boot scrapers or water bin.
- There is also the related issue of keeping ladder rungs clean - the accident happened on the way down; it may not have been mud on the boots themselves.
- What specific safety advice and training is generally available on these issues? How is disseminated? Does the dissemination really get to those at risk in a form that demands attention, as opposed to 'something to read and sign for'?
- Safety culture - There is much evidence in the data that the safety culture on the site is poor. The impression is of a site, on which safety issues are a side issue, to be addressed when forced to, rather than central to the production management process.

- The respective responsibilities of the PC and the SC seem to be unclear, at least to those involved on site.
- There is mention of instructions from the SO (which SO - PC or SC?) and Safety Rep. Where are these recorded and were they discussed at safety or general planning meetings?
- Some suggestion that lack of job security may have negatively affected the safety culture

Case study	**63**		
Construction type	Major Building	**IP Role**	Bricklayer
Construction phase	Middle	**Employer status**	SC
Timeliness	Late		

Accident description
'While fixing a 'tek'[13] screw to a steel column within the car park a small fragment of steel was projected into the eye of [IP}. [IP] received first-aid (eye wash) and then was taken to hospital where the fragment was removed. [IP] returned to work the next day. (Quote from accident report).

Emerging Issues
- PPE - 'wear-ability' of goggles/glasses and steaming up – an equipment design issue - has it been solved by any manufacturer? - Is it a cost issue? Safety glasses would probably be sufficient for this task.
- Tool design - Do any electric hand tool manufacturers make protective shields to attach to the 'drill'? At first sight it would not seem difficult to provide a clear plastic plate, possibly angled, to allow the operator to see the bit (or drill) and screw/work area, but providing protection from flying swarf. It would tend to get scratched and eventually opaque but better than nothing and cheap to replace.
- Work position/work sequence - Working overhead is always going to be more difficult, uncomfortable, tiring and therefore dangerous. Could the operative have carried out the task from a different position or in a different sequence, with a bit of forward planning, to permit a better work position? Could it even have been done before the steel was fixed in position? Even, perhaps, by the steel erectors?
- Safety culture - There is little evidence of the PC's safety management at all, except for the mention of induction. There is a definite overall impression of the PC being rather 'hands-off' and maybe trusting to luck or simply hiding behind the SC responsibilities.

Case study	**64**		
Construction type	Major Building	**IP Role**	Pipe fitter
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
'Walking (across the floor slab) - IP tripped on a floor setting out point that was not marked and twisted left knee'. (Quote from accident report).

[13] *'Tek' term used by interviewees in this accident study to describe self-drilling /self-tapping screws – They may not have been manufactured by Tek.*

Emerging Issues

- IP's comment on remedial action - At time put a traffic cone over the top – but the cones get moved because these are in access routes. Thinks that PC put these in too early – they should be done just before the area gets screeded over.
- Setting out points are an essential part of the construction process – However, and perhaps because of this, they are frequently overlooked as trip hazards. Most safety advisors would probably walk passed such a hazard and not even notice it.
- The main issue may be one of establishing and maintaining safe walk-ways.

Case study 65

Construction type	Major Building	**IP Role**	Bricklayer's labourer
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

'Whilst lowering hod full of bricks, bricks tumbled out and squashed little finger on right hand, breaking skin. (Quote from accident report).

Emerging Issues

- Are hods still an acceptable method to transport bricks – what are the alternatives?
- Pre-assembled brickwork would have prevented the need for bricks on site – was this option considered viable?
- What training did the IP have regarding the use of the hod – probably none as it is considered something that every bricklayer's labourer can use.
- No gloves? – Why not? – Use-ability/comfort/availability etc

Case study 66

Construction type	Major Building	**IP Role**	Dryliners' labourer
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

I was on my way down to tea break when I saw a piece of the metal strut sticking out at eye level and I tried to remove it and cut my hand (this is part of his job) (IP interview account)

Emerging Issues

- This appears to be a design issue? Why was the metal sticking out after it had been installed? An obvious hazard! Should it have been there (i.e. part of the construction)? Was it fixed? Could it have been 'designed out'?
- Training of tradesmen (dryliners) - any safety content to avoid leaving sharp edges sticking out - if no formal training of dry-liners, as a trade, why no TBT training on responsibility to other workers, specific to the job?
- Training and supervision of IP - Why not encouraged (told) to wear gloves when handling potentially sharp objects?
- The 'manager' says it is not possible to be there 24 hours a day but is there REAL encouragement to wear gloves?
- Availability of PPE - no mention of gloves in the list of PPE provided – Why not? - Are they provided and by whom?

Case study 67

Construction type	Major Building	**IP Role**	Site electrician
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
Whilst walking on the deck making preparation for a transformer, IP stepped on a piece of wood with nail in it (from accident book).

Emerging Issues

- IP commenting on housekeeping- 'could have been tidier, there are plenty of skips available but people don't use them enough'.
- What is the housekeeping management system on this site? Is there a gang (person) responsible for keeping the site clear and safe or is it 'everybody's (or nobody's) job'? What training is given? How often? When was it last given – and was housekeeping given proper focus?
- How are managers/supervisors trained to deal with housekeeping? Are they, themselves supervised by senior management? When was the last time that a senior manager visited and mentioned housekeeping?
- What is the relevant company policy and how is it administered?
- Is there a real danger for electricians wearing steel-soled boots and, if not, why does the IP think there is training?
- Why were appropriate boots not provided and insisted on?

Case study 68

Construction type	Major Building	**IP Role**	Site Labouring
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
The IP was walking through props (temporary works) and stood on a sleeper prop, knocking the prop over which fell and landed on his head then onto his shoulder (from accident book).

Emerging Issues

- This seems to be all about training and site management systems.
- The IP was walking between jobs
- Should the IP have been walking between the props? If not, what is done to prevent this happening - induction, and supervision?
- Should the props not have been cordoned off?
- Should this have been written in the risk assessment?
- Should the prop have been properly secured? If so, what is the content of trade, induction, and TBT training to try to ensure that appropriate precautions are taken; and how is this training reinforced through supervision?
- If the props can be left in an unstable condition (to say nothing of the formwork that they support), then what warning notices or other systems are in place to ensure that nobody gets hurt?
- Why hadn't the props been checked to make sure that they were all tight?
- Could the design been changed to prevent the use of props?
- Could the need for in-situ concrete have been designed out, to avoid this and many other potentially dangerous (and unhealthy) situations?

Case study 69

Construction type	Major Building	**IP Role**	Construction Manager
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
Shutter (being lifted by crane) knocked the IP down one flight on ladder, leaving his left hand bruised-sore side and back-sprained fingers (taken from accident book). Supervisors comments- Accident cause 'this really was a "freak accident" the shutter caught the top of the ladder and knocked him off'.

Emerging Issues

- This seems to be mainly a problem of inadequate work and logistics planning, RA and safety training.
- Why was a table form shutter being slung into position near an access area (ladder)? Ladder access, or indeed any pedestrian access, immediately below work with a crane must be a potential danger - was it considered and why was the ladder not either removed or access blocked? Surely this should not have happened- this issue should be written in the Risk assessment.
- Wind is often a problem when using a crane to lift large panels. Why were they moving the shutter when it was so windy? Was wind considered in the RA or in short-term planning? (e.g. was the weather forecast available and discussed?)
- There seems to be an underlying lack of consciousness of danger in many of the statements and little concern for training - safety culture is not good, in spite of the belief of the employees - why so little training and why was this particular type of danger not covered?
- Design - could in-situ concrete have been avoided altogether?
- Working hours - 12 hours a day, with a half hour break, is too much and likely to lead to tiredness and lack of concentration - could this have been a factor? - There is no time of day recorded for the accident, but in any case, this sort of schedule must lead to cumulative tiredness, especially in a physical occupation.
- Remedial action = none, which suggests that the site did not see that there were things that could have prevented the accident.

Case study 70

Construction type	Residential	**IP Role**	Ground worker
Construction phase	End	**Employer status**	PC
Timeliness	3 weeks late		

Accident description
The IP was putting rubbish in the skip and a slab fell over and landed on his foot (from accident report). IP Accident description: 'I was cleaning up the site. There was a pile of slabs by the skip and the strap round them was broken and the slabs were held up by a piece of wood. As the excavator drove passed the vibration of the machine dislodged the wood just as I was passing by and one of the slabs fell onto the bridge of my foot.

Emerging Issues

- This is typical of sites when nearing the end - trades and materials tend to be everywhere- Would it not have been better to store the slabs at the intended installation location? Why wasn't this done?
- Why hadn't slabs been supported/ stored better? - not enough site supervision?

- Has supervisor done site inspection may have revealed the slabs were stored unsafely
- Training on material storage?
- Remedial action= slabs were tidied up and made safe, which suggests that the site did not see that there were things that could have prevented the accident.

Case study 71

Construction type	Residential	**IP Role**	Plumbing installation
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

IP's version of the accident: 'I was testing out the heating system, but the pump wasn't wired up so I got the apprentice electrician to wire the pump in, when I switched it on the boiler cut out so I went up to see if the pipes were getting hot and held the pipes close to the pump, and I was electrocuted. The current held me in for about 15 seconds.' Plumbing manager's version: 'Basically it was a wiring problem- a design fault that was overlooked by the manufacturer- The push-in electrical socket was put in the wrong way by the apprentice electrician making the appliance "live". This gave the IP an electrical shock.'

Emerging Issues

- Manufacture error - pump was modified by manufacturer after accident
- Why didn't the pump 'fail-safe'
- Was wiring error obvious? Why not?
- Remedial action = 'We traced all the said pumps (100) and removed them- the manufacturer was informed subsequently the pump has been removed from the market'.

Case study 72

Construction type	Major Building	IP Role	Brickwork Manager
Construction phase	Unknown	Employer status	PC
Timeliness	On time		

Accident description

'Quickform' scaffold fell over damaging helmet and knocking IP over. (From accident book) The works manager (PC) version: 'The materials were not stacked properly- and the scaffolding fell onto him

Emerging Issues

- This could have been very serious, site storage and planning of operations needed to be addressed better, especially as this accident was in a major walkway.
- Scaffold workers/ erectors (should have been stored better).
- Why was there scaffolding lying around that could fall?
- Were too many trades working in one area?
- What was housekeeping system?
- Remedial action = stacked the scaffold properly and removed to storage areas, which suggests that the site did not see that there were things that could have prevented the accident.

Case study 73

Construction type	Major Building	**IP Role**	Groundworker
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
IP got his foot caught in piece of 'rebar' sticking out of the crushed concrete hardcore and fell onto stub column- bruised right side just above hip (taken from accident book).

Emerging Issues
- This is a design issue relating to specification of re-cycled hardcore.
- Similar accidents had happened previously on this site with trips and falls on the hardcore. They were using hardcore from the site demolition, it clearly wasn't crushed enough- down to the specification. It was not clear who was responsible for hardcore specification?
- Should rebar have been removed? - Why not seen as a hazard?
- Workers responsible for laying hardcore- "eyeballing" for problems – Is this effective?
- Site manger – housekeeping/ safety checks – Why weren't they done? What was the system?

Case study 74

Construction type	Major Building	**IP Role**	Scaffold erection
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
Holding chain sling from fork lift around tower used by steel fixers on columns- chain slipped and tightened around left hand thumb causing bruising to shank of thumb (taken from accident book). IP's version of the accident: 'We were slinging the tower and the chain came across my thumb- caught chain between scaffold tube and the fork. It is hard to control the lift when using the forks as they jerks when you lift- really we should have been using the crane but it was being used elsewhere'.

Emerging Issues
- Why wasn't the crane free to take down scaffold rather than the fork lift? - Scheduling
- Why were they allowed to proceed without using the crane?
- Was the forklift 'approved' for this use?
- Was forklift 'designed for this use?

Case study 75

Construction type	Major Building	**IP Role**	Setting out engineer
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP trod on ½ brick and turned right ankle that had swollen. Ground is made up with crushed brick material and it is inherent that these materials will be loose (taken from accident book).

Emerging Issues

- IP was walking around the site - See accident 73 regarding hardcore specification.
- Who made the decision regarding the ground fill material- not broken up finely enough?
- Was the hardcore sufficiently compacted?
- Was this risk acknowledged by designers, specifiers and installers? – If not, why not? – If it was then why wasn't anything done?

Case study 76

Construction type	Major Building	**IP Role**	Formworker
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

IP was walking between jobs. Scraped shin on bars in top of columns which lock into slab (starter bars) (from accident record).

Emerging Issues

- The main issue here seems to be why was the footpath /access route so close to the protruding rebar?
- One of the steel fixers had had a similar accident the day before. Why was something not done?
- Could protruding bars have been protected / highlighted in some way? Is there any provision in the method statement for protection of work? If not should this be included?
- Why was rebar sticking out of columns? Could it have been designed out? – Yes, but only for a period and only in a way that would significantly increase the cost.
- IP had read the MS and thought it was fairly easy to understand. It was helpful and appropriate in fact it was very specific to the task – But this 'activity' was off-task.

Case study 77

Construction type	Residential	**IP Role**	Apprentice carpenter
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

IP was putting a roof-trussed rafter up. He walked backwards along the working platform of the scaffold. At some point he stepped into a void in the platform created by two missing battens. Unknown persons had removed these. He knew they were missing and perceived this hazardous but took no action to rectify it. IP fell through the void injuring his ribs (From accident record).

Emerging Issues

- The whole issue of the boards being removed was passed from trade to trade and no-one admitted to it.
- Why were boards moved? - No one saying.
- Why hadn't they a) put the scaffold boards back or b) reported that they had been moved? If they moved them – why?
- Non-conformance with the MS for the task supervisor aware of the missing boards, but continued to work.
- Was there enough space for working?

- This was a difficult crane lift – Why were they proceeding in wet/windy weather?
- IP had not seen the RA or MS for the task
- IP's partner was on piecework therefore was he tempted to work when unsafe?
- IP was having apprentice training at the time from a carpenter on piece work- is this good practice?

Case study 78

Construction type	Major Building	**IP Role**	Electrician
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
Gash above left eyebrow after heavy armoured cable became loose and fell across side of IP's face (from accident book). IP's version of the accident: 'I was working in the switch room which is quite confined. There was the main supply coming in (75mm armoured cable) on a reel lying on the floor so I stood it up and tied it up by the fuse board. The weight made it fall over and it fell onto my left leg'.

Emerging Issues
- Why was the cable so long? Should it have been cut off by the electricity company?
- Inadequate working/storage space.
- Should the reel of cable have been stood on its end?
- Why hadn't the cable been cut back previously: "In hindsight the cable should have been cut off beforehand as there was no need for the reel of cable to be there" (Supervisor)
- Remedial action: tied it back up again. The remedial action says it all!
- Why wasn't any further remedial action taken to provide more or better storage?

Case study 79

Construction type	Major Building	**IP Role**	Scaffolder
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
Walked away from point of attachment to extent of lanyard causing sudden jolt. Pain in lower back at base of spine (from accident book). IP's version of the accident: "I was fitting the scaffold out with boards and tubes. I was hooked on to the scaffold top rail with my harness I tried to pick up a *21 footer* (scaffold tube) past the length of the lanyard and hurt my back - to be honest I forgot I had it (the harness) on." Supervisor described it as a 'freak accident? IP forgot that he had his harness on and moved beyond its reach and consequently hurt his back'.

Emerging Issues
- Was the harness worn correctly?
- Was this obvious?
- Was IP trained?
- Did IP understand harness limitation?
- Why did he 'forget' it was on?
- What does this say about the IP's attitude towards a safe working environment and PPE?
- Was method statement clear about when harnesses were necessary?

Case study 80

Construction type	Residential	**IP Role**	Carpenter
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP was fitting a garage door, finger was trapped between latch plate and garage frame- left hand tip of thumb (from accident report). IP's description of the accident: 'I was putting a garage door on- screwing the lock in position which snatched my hand trapping my thumb between the mechanism and the frame'.

Emerging Issues
- Is this a manufacturing issue or was he just going too fast as he was working on a price?
- Should he have been wearing gloves? Were they available / suitable?
- Sounds like a two-person operation – why was he alone?
- Was sufficient task lighting available?

Case study 81

Construction type	Residential	**IP Role**	Bricklayer labourer
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description
IP tripped on a broken brick on the scaffold (taken from accident book). IP's version of the accident: 'I was walking on the scaffold, stood on half a brick and twisted my ankle'.

Emerging Issues
- His job was to clean the scaffold which he didn't do - He should know this is part of his job – but it should be written in a MS or job description
- Housekeeping- IP should have cleaned it up in the first place?
- Housekeeping on scaffold – was not being tidied. Time pressures at the time of the accident were due to 'price work' payment for brickwork, which may have discouraged IP from cleaning/clearing the scaffold.
- IP dissatisfied with job and place of work – this may have affected his inclination to keep work area tidy.
- Training on H&S by the site manager?
- Remedial action: IP cleaned the scaffold, which suggests that the site did not see that there were things that could have prevented the accident.

Case study 82

Construction type	Residential	IP Role	General site labourer
Construction phase	Middle	Employer status	PC
Timeliness	On time		

Accident description
IP, whilst tidying round a scaffold bent over hat fell off, when picked it up tried to stand up to put it back on, didn't notice scaffold tube and hit causing cut to temple (taken from accident book) IP's version of the accident: 'I didn't have my hard hat on at first and as I was lifting some concrete from under the scaffold I hit my head on a scaffold tube'.

Emerging Issues

- Commenting on PPE, IP stated: "I don't like wearing them that's why I had my hat off - I bought my own boots as they are more comfortable.
- Perhaps there should be better training on PPE use and care?
- Training on H&S by the site manager?
- Safety procedures?
- Lots of negative comments about job satisfaction – possibly leading to disregard for safety?

Case study 83

Construction type	Residential	**IP Role**	Trainee Site Manager
Construction phase	Middle	**Employer status**	SC
Timeliness	On time		

Accident description

IP was moving glass and cut his finger (taken from accident book). IP's description of the accident: 'I was moving a piece of glass in the container and a splinter went into my little finger'.

Emerging Issues

- Should have been wearing gloves if it is necessary to handle glass - Injured party at fault therefore no causal chain?
- Did MS state that when handling glass all operatives should wear gloves? Is this enough?
- Were appropriate gloves available? Why didn't the IP wear them?
- Was the temporary lighting sufficient?
- Why was the glass broken?
- Why was a trainee site manager moving glass?
- Remedial action: made people wear gloves when handling glass.

Case study 84

Construction type	Civil Engineering	**IP Role**	Ground worker
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

IP was placing kerbs, lost grip, block fell onto fourth finger of right hand causing slight bruising (taken from accident book). IP's description of the accident: 'I was picking a kerb up and I dropped it trapping my finger between another block'.

Emerging Issues

- This was the first time he had done the task. Therefore had he had sufficient training for the work?
- Also he was working on his own for a first time task. He had had not been on any courses prior to the accident either.
- Why were better gloves for the task (i.e. more grip plus protection for the fingers) not available?
- Who chooses gloves? What is the purchase strategy?
- Manual handling – was the kerb stone too heavy to be lifted? Was there/is there specialist equipment that could have been used for the task?

- Were risk assessment and method statement in place?
- Could the designer / supplier have designed kerb better to ease installation and manual handling?

Case study 85

Construction type	Civil Engineering	**Contract type**	Joint venture
Construction phase	Middle	IP Role	Trainee foreman
Timeliness	On time	Employer status	PC

Accident description

Leg was caught by the JCB[14] whilst walking past (taken from accident book). IP Accident description: my leg (right) was run over by a JCB whilst I was helping the JCB driver pick up a compressor.

Emerging Issues

- Should the trainee foreman have been doing this? Clearly he was not trained for the job.
- Should they have been working in this weather?
- Was the JCB the right plant for the job?
- Co-ordination between the JCB driver and the foreman during the accident task was insufficient
- Was the work area too confined for the task?
- Was correct lifting equipment being used to pick the compressor up?
- Did the site conditions (wet & muddy) play a part in the accident?
- Lack of supervision?
- No method statement or risk assessment.
- Did design allow for enough working space?

Case study 86

Construction type	Civil Engineering	**IP Role**	Plant operator
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

Cut inside of left hand on piece of metal from the pile (taken from accident book). IP Accident description: 'I got out of the machine and walked past one of the piles tripped and grabbed the pile and a metal splinter went into my left hand palm through the glove'. Supervisors comment on the accident cause: 'he was trying to get past the pile and caught his hand on a spike sticking out'.

Emerging Issues

- Was there the need to walk so close to the piles? Walkway required?
- Gloves were being worn but were they in good condition and of acceptable quality/thickness/toughness?
- No information on the type of piles - but could the splinter that caused the injury have been removed in the manufacture or protected on site, to prevent the possibility of the injury?

[14] *'JCB' term used by interviewees in this accident study to describe multi-functional back-hoe excavator – The excavator may not have been manufactured by JCB.*

- Otherwise, difficult to see how the accident could have been avoided except by the IP taking more care - possible general training issue.
- Were gloves of a sufficient thickness/quality?
- What did the IP trip over – site tidiness?
- Confined working area – design consideration?

Case study 87

Construction type	Civil Engineering	**IP Role**	Apprentice Formworker
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
IP was dismantling timber shutters using crow bar and strained his wrist (taken from accident book)

Emerging Issues
- The IP does the task frequently so one may presume he was fully trained and had sufficient experience for the task?
- Can this operation be classified as a repetitive strain injury?
- Assuming that the IP was using the correct tool, and there is nothing to suggest otherwise, then he must have been using it in the wrong way. This makes it an ergonomics problem. To take this any further, it would be necessary to know much more about the way that the task was being carried out.
- If it was being done in a potentially dangerous way, then it also becomes a training issue.
- What specific training had the IP had in positioning himself correctly in relation to the work piece, positioning and supporting the work piece, handling hand-tools safely, etc.

Case study 88

Construction type	Residential	**IP Role**	Trainee scaffolder
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
Whilst carrying scaffold clips he tripped on a brick band falling to the ground causing an injury to his left side. Later report given saying there was rib damage (taken from accident book).

Emerging Issues
- The IP was carrying the clips in his arms in front of himself - a manual handling issue - How is the operative trained to carry scaffold clips? Is it written down anywhere? Even if it is, how is the method communicated to the operative? He should have been trained to carry them in a sack or a bucket or another carrying device
- Site housekeeping poor (ish) at the time of the accident - What is the system is for dealing with housekeeping. Is it a specifically allocated responsibility? Is there sufficient time allowed for dealing with it? What does the person (or gang) who are supposed to deal with it think of the arrangements? etc.
- As it happened quite early in the day, there does not appear to be a reason for carelessness or lack of concentration.
- Why did his supervisor allow him to proceed?

Case study 89

Construction type	Major Building	**IP Role**	Joiner
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
IP was trying to straighten a starter bar. His mate was holding the top of the rebar whilst the IP hit it with a sledgehammer to straighten it. On approximately the third hit the rebar bounced out of the hands of his mate and hit the IP on the side of the head. This area swelled up, there was a small cut but it did not bleed.

IP Accident description: "I was trying to straighten a starter bar. My mate was holding the top of the rebar whilst I hit is with a sledgehammer. On about the third hit the rebar bounced out of the hands of his mate and hit me on the side of the head."-

Emerging Issues

- If the bar was a starter bar (presumably already concreted in), why was mate holding it? – if not already concreted in, then becomes very dangerous to be hitting it with sledge, while held.
- Surely this practice is not written in the MS – Therefore, no MS/RA for the accident task
- Using wrong tools - a training and supervision issue. Had IP ever had instruction as to the correct way of carrying out the task? Were the correct tools available? The supervisor stated that "the IP was using the wrong equipment for the task" – But what would be the right equipment?
- Is bending damaged bars straight acceptable under the spec. anyway? i.e. is it a recognised task?
- Site organisation/housekeeping - If the bar had not been damaged, the accident would not have happened. What protective actions are taken to avoid damage? Why did they fail?
- Why did supervisor not stop the activity and make sure that they used the correct equipment?

Case study 90

Construction type	Major Building	IP Role	Joiner
Construction phase	Middle	Employer status	PC
Timeliness	On time		

Accident description
IP was assisting co-workers to move a table deck on a trolley when it toppled and fell onto his leg causing a deep cut to the left shin. IP accident description: "I was helping three others to move the table deck, because the gang member who normally does it was off doing something else.

Emerging Issues

- Was the trolley faulty? Who should have checked? Is it a common problem that the wheels on the formwork table trolley's get damaged? Effect of site housekeeping on the wheels? Effect of use on the wheels – i.e. had it been misused?
- There is clearly an issue of trolley design. It is neither suitable for the difficulties frequently encountered nor robust enough to stand up to site conditions.

- There is the question of suitability of the IP for the task being undertaken - he was not the usual operative for the task, and maybe not thoroughly familiar with the particular handling problems; he was also maybe somewhat elderly to be undertaking such a physical task.
- What, if any, preparations are made (or could be made) to the work area to prevent trolley wheels running into a gulley - could it have been covered?
- What about pre-planning of the work area?
- There is also the question of training for manual handling. It is frequently the case that operatives will 'dive' into a heavy task with inadequate thought as to exactly how it is to be accomplished and who is to do what. For example, was the route that the trolley was to take, in this case, planned to avoid the gulley in the concrete, or did they just plough on regardless?
- The pressure is normally to get the task done, even if there is no explicit time pressure and little or no training in task planning.
- IP should have not been doing the task.

Case study 91

Construction type	Major Building	**IP Role**	Joiner
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

IP was erecting a wall shutter and although he was aware of a piece of protruding scaffold behind him, when he turned round he caught his head on it and cut the bridge of his nose. His helmet took the brunt of the blow.

Emerging Issues

- Remedial action - the piece of scaffold was removed to prevent recurrence of the incident. This should have been picked up earlier. Workers should be encouraged to report potential hazards.
- Layout of site (Permanent works design issue) – not enough space for working.
- Design of scaffold not suitable.
- Responsiveness of management – IP had already mentioned the issue previously and no action had been taken.

Case study 92

Construction type	Major Building	**IP Role**	Electrician
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

IP was working in a ceiling void pulling cables through when he caught his elbow on the ceiling trim causing a cut to his arm (From accident book). Supervisors comments: “The accident was a common occurrence; it is very easy to catch your arm on the grid, especially if not wearing long sleeves.

Emerging Issues

- Remedial action – IP told to wear long sleeves when doing that task. In the MS should electrician be wearing overalls?
- Protection of IP through adequate PPE - even long sleeves do not seem entirely satisfactory as they would only partially protect against really sharp edges and would be snagging all the time, impeding work and causing distraction. It would seem worthwhile to investigate a more suitable form of personal protection, say a type of leather arm protector or long gloves.
- Could the ceiling components be protected around their sharp edges, at least where the wiring has to be pulled through?
- Can the ceiling components be designed differently, so that there are no such sharp edges?
- There is also the issue of excessively long working hours. 11-hour days are bound to result in fatigue and loss of concentration.
- Did the task have to be completed after the ceiling grid was in place?
- Did the design &/or installation of the ceiling grid mean that it was sharper than other types?
- Are there other methods of work/types of ceiling systems that are easier to work around?

Case study 93

Construction type	Major Building	**IP Role**	Bricklayer
Construction phase	Middle	**Employer status**	PC
Timeliness	Shell – behind Fit out - ahead		

Accident description

Concrete fell from pour above. The men moved away, came back to work on 1st lift block B, when more concrete fell and splashed into eye of IP. (Taken from accident book).

Emerging Issues

- Planning issue why were they working underneath a concrete pour?
- What is the process of short-term planning?
- Is there any systematic way in which the potential for this accident could, and should, have been recognised?
- What does the main programme, MS and RA actually say about this issue? Sequencing of trades and co-ordination of trades on site – i.e. to prevent trade overlap.
- Was the actual activity being carried out of sequence? If this happens, how is any consequent danger SUPPOSED to be noted? Why wasn't it?
- There are many indications that the site communications are not what they might be. How come that this event was repeated several times, without it being noted and action taken?
- Is the general site culture, or particular individuals, providing resistance to free communication?
- Are concerns listened to and acted upon (there is some evidence to suggest that they are not)? What should happen? What is the reporting system?
- Looking further upstream, did the design influence the construction sequence in a way to increase the risk of this accident (and it could, presumably, have been much more serious with heavy and difficult material like concrete being handled immediately above a working gang). Could a different design have avoided this circumstance? Was there a design risk assessment and did it have anything on this issue?

Case study 94

Construction type	Major Building	**IP Role**	General Labourer
Construction phase	Middle	**Employer status**	PC
Timeliness	Shell – behind Fit out - ahead		

Accident description
IP was breaking concrete in lift pit using electric breaker. Whilst using the breaker it burst into flames, burning the IP's ring finger on left hand (from accident book).

Emerging Issues

- Had the equipment been PAT tested? Is it policy to PAT test equipment on site?
- Had the supplier done any checks on the equipment prior to bringing it to site?
- Was it properly maintained? - Check maintenance records, record of electrical safety checks, source of tool (e.g. hire company).
- If it looked "dodgy" the users need to learn to report potential problems
- Was the tool adequate for the job being undertaken? - was it powerful and robust enough?
- Was it being (or had it been) incorrectly used? - e.g. was it being handled in such a way that the cables were likely to be damaged? The Site Manager seems very sure that it had been mishandled - why had he done nothing about it?
- Training in the correct use and care of breakers and their electrical tools? There had apparently been none.
- Tool design - given that it was probably common practice to 'drag it around by the cables', are the cables and fitting designed (or could/should they be) to stand up to this treatment?
- Without good training AND better supervision it WILL happen.
- Why had the supervisor not commented to the labourer that he shouldn't be picking the breaker up by the cables?
- Why was the labourer not wearing gloves?

Case study 95

Construction type	Civil Engineering	IP Role	Assistant engineer
Construction phase	Middle	Employer status	PC
Timeliness	On time		

Accident description
IP was knocking in a peg when it split at the bottom on the first hit. On the second hit hurt his finger. Was using a sledgehammer at the time.

Emerging Issues

- Was the correct equipment being used at the time (i.e. correct size sledgehammer)?
- Were the pegs faulty? Is there any check of the quality of the pegs?
- Is there proper supervision i.e. Equipment being used by chain lads?
- Why was the IP not wearing gloves?

Case study 96

Construction type	Civil Engineering	IP Role	Assistant Engineer
Construction phase	Middle	Employer status	PC
Timeliness	On time		

Accident description
IP was stacking rolls of terram when one slipped. IP tried to stop it rolling causing fingers to be bent back, this caused bruising and swelling.

Emerging Issues

- His supervisor put it down to "horseplay" which is possible.
- IP recorded a high degree of negative scores in the job satisfaction chart.
- Why was an engineer handling the terram?
- Was the stack to high?
- The accident may have been due to carelessness or inexperience but to call it horseplay suggests an inappropriately cavalier attitude on the part of the Site Engineer and his remedies do not seem constructive. Is this indicative of a culture of safety carelessness among middle management?
- Why was an assistant engineer moving Terram anyway? Not a usual task.
- 1.5m high seems much too high for a pile of heavy rolls - surely potentially unstable and too high to lift from with safety. The whole question of safe material storage and handling should be looked into on this site. What are the company rules/guidelines and training approaches to this issue?
- Was the IP properly supervised at the time? Should the IP have been undertaking the accident task? Were the rolls of terram stacked properly – was the pile too high?

Case study 97

Construction type	Civil Engineering	**IP Role**	Assistant engineer
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
IP hit left shin with 7lb sledge hammer causing bruising (from accident book).

Emerging Issues

- The remedial action says it all, coupled with follow-up statements- Remedial action= None apart from a personal realisation about what to do next time.
- Training - the IP 'had task training' but did it include handling sledgehammers and positioning of body relative to work task?
- Was the 7lb sledge appropriate - would a lump hammer not have been better for someone unused to handling heavy tools?
- What does 'training manual', if there is one, say about this issue?
- The problem seems to have been recognised before - what is the site communication system for such issues and why did it not work - yet anyway?
- Is there proper supervision re. Equipment being used by chain lads?
- Had the IP lost focus at the time of the accident?

Case study 98

Construction type	Civil Engineering	**IP Role**	Joiner
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description
IP was cleaning shutter with metal scraper, scraper head caught a nail, which forced the handle into the side of IP's neck causing bruising (from accident book).

Emerging Issues

- The main issue seems to be task and tool design.
- Was the task being attempted in the most ergonomically beneficial way?
- Was the shutter upright or horizontal and was it most easily cleaned in the way it was positioned?
- Was the scraper easy to control? Was it the best tool for the job - e.g. would high-pressure water jet be better?
- Had shutter been adequately prepared for the previous pour - e.g. sufficient release agent?
- Excessive working hours (11.5 per day) and an accident happening late in the day maybe an issue. Is this a case fatigue?
- Lack of control of a long-handled tool becomes much more likely with fatigue.
- Why had the shutter not been checked for nails before the cleaning began?
- Nearly all positive ratings in the job satisfaction - enjoys his work.

Case study 99

Construction type	Civil Engineering	IP Role	Joiner
Construction phase	Middle	Employer status	PC
Timeliness	On time		

Accident description
IP was drilling a hole in shutter and brushing dust away, caught fingers in drill and broke 2 of them. IP accident description: "We were drilling a hole in a shutter and needed to brush away the dust that was being created around the hole – whilst doing this I took my eye off it and caught my fingers in the drill and broke 2 of them". IP rated it a very easy task.

Emerging Issues

- Carelessness and taking obvious risk but fatigue from excessive working hours (IP 10.5 hour day and foreman. 11.5 hour day) could have had something to do with it. Accident was on a Monday and the IP last day off was 4 days ago - worked weekend? This situation is likely to lead to fatigue, boredom and careless actions.
- Foreman reference to gloves is hardly relevant - the accident could even have been made worse - but the IP reference to being told to use the correct tool is interesting and in relation to training and supervision.
- Was task being done at the workface? Could it have been done in the site joinery shop, if there was one, or even off site? Thus giving a greater of control and better machinery.
- Why was the correct tool not being used?
- Why did the supervisor allow them to proceed without the correct tool?
- Why had the IP not received training in the use of the equipment?

Case study 100

Construction type	Major Building	**IP Role**	Bricklayer
Construction phase	Middle	**Employer status**	PC
Timeliness	On time		

Accident description

The IP was walking along scaffold when IP felt a board move underneath him. IP fell though about 0.5m.

Emerging Issues

- The IP was walking between jobs. This could have been very serious- a near miss?
- How often is scaffolding checked? Is this weekly daily?
- Unqualified and irresponsible operatives modifying scaffold. The answers must lie in training (not to), supervision (to prevent) or frequent inspection of scaffold to remedy any deficiency.
- Had the scaffolders not been available to make the adaptations themselves?
- Expected practice, actual current operative practice, relevant training and supervisory practice, including sanctions adopted in the event of expected practice not being followed?
- Some sites operate, or at least threaten, instant dismissal if seen without a hard hat. Yet the practice of removing elements of scaffold, without prior permission and appropriate safeguards, seems much more serious, in that it puts others at risk. Why not the same policy here?
- Operations planning -Was the interference of the scaffold anticipated? If not, why not? What sort of systematic short-term planning takes place?
- Could another form or method of construction that does not require scaffold, or even insitu brickwork, have been selected?
- Why had the bricklayer moved the scaffold? – had it not been put up as required?
- Why had the supervisor allowed them to move the scaffold?
- Co-ordination/communication between the bricklayers and the scaffolders?

APPENDIX C

POTENTIAL ACCIDENT SEVERITY

Potential Accident Severity

Study No	Outcome / injury (actual)[15] (1)	Potential outcome /injury (likely)[16] (2)	1-3-days[17]	> 3-day	Major	Fatality	Potential outcome / injury (possible)[2] (3)	1-3-days	> 3-day	Major	Fatality	Comments (4)
001	Struck by rebar tie-wire – injured eye	Loss of sight or penetrating injury to eye			✓		Loss of sight or penetrating injury to eye			✓		Severity depends on 'chance'
002	Cut by circular saw – injured hand	More serious hand lacerations requiring time off		✓			Even more serious hand injury – loss of fingers or use of hand			✓		Severity depends on 'chance'
003	Fire – no injury?	Injuries from fire – eg requiring hospitalisation			✓		Fatalities from fire				✓	Severity depends on chance and effectiveness of emergency procedures
004	Struck by falling prop – injured back	More serious back injury or shoulder dislocation – eg requiring hospitalisation			✓		Serious head injury leading to fatality or permanent disability				✓	Severity depends on body part hit
005	Struck when dropped steel angle – injured finger	More serious crush injury to hand - eg requiring hospitalisation			✓		Loss of finger / hand			✓		Severity depends on 'chance'
006	Ring snagged on protrusion – injured finger	Fracture to finger requiring time off		✓			Loss of finger			✓		Severity depends on 'chance'
007	Cut with knife whilst cutting board – injured leg	More serious leg laceration requiring time off		✓			Other laceration – eg leading to loss of finger or hospitalisation			✓		Severity depends on 'chance'
008	Hit self with scaffold tube – injured foot	Fracture to toe requiring time off		✓			Serious fracture to foot / ankle leading to hospitalisation			✓		Severity depends on 'chance'
009	Struck by steel 'banding' to brick pack – cut arm	More serious laceration to arm or other body part requiring time off		✓			Loss of sight or penetrating injury to eye			✓		Severity depends on body part hit and use of appropriate PPE

[15] *Incident outcome and resultant injury summarised from accident book record and interview data.*
[16] *Potential outcomes have been established as 'likely' and 'possible' based on the RIDDOR classification. This rationale is based on an evaluation of the incident information and evaluation of alternative outcomes if the IP had been in a slightly different location or if a different part of the body had been involved. Likely outcomes require only a minor change in circumstances; possible outcomes would require a number of circumstances to change for them to occur.*
[17] *Outcome categories based on RIDDOR classification. Some of the 'major' incidents may have led to permanent disability and hence loss of the individual to the industry.*

Study No	*Outcome / injury (actual)*[15] *(1)*	*Potential outcome /injury (likely)*[16] *(2)*	*1-3-days*[17]	*> 3-day*	*Major*	*Fatality*	*Potential outcome / injury (possible)*[2] *(3)*	*1-3-days*	*> 3-day*	*Major*	*Fatality*	*Comments* *(4)*
010	Struck by falling formwork during removal – minor injury	*More serious injury - eg shoulder dislocation*			✓		Fatality or permanent disability from falling formwork				✓	Severity depends on body part hit
011	'Hiab' delivery vehicle overturned whilst off-loading – no injury	Permanent disability or fatality from crush injury				✓	Fatality from crush injury				✓	Plant-related – serious potential consequences - Severity depends on 'chance' and body part hit
012	Struck by 'foam' ball and concrete whilst clearing concrete pump line – groin and back injury	More serious impact injury requiring time off		✓			Even more serious impact injury - eg dislocation of knee or hip, or requiring hospitalisation			✓		Severity depends on 'chance' and body part hit
013	Screwed through wood into finger using powered screwdriver – injured finger	More serious hand laceration requiring time off		✓			Possible loss of finger			✓		Severity depends on 'chance' and location of impact
014	Cut self with knife – injured finger	More serious hand laceration requiring time off		✓			Even more serious hand injury - eg loss of finger			✓		Severity depends on 'chance'
015	Struck by concrete slab whilst demolishing – cut hand	Fracture or hospitalisation (eg from head injury)			✓		Fatality from head injury				✓	Severity depends on 'chance' and body part hit
016	Fall from step ladder – injured leg and elbow	Dislocated knee			✓		Even more serious fall injury eg falling onto sharp object			✓		Severity depends on 'chance' and body part hit
017	Tripped over cable – injured ankle	More serious trip injury – eg dislocation of knee			✓		Even more serious trip injury eg falling onto sharp object or fall from height			✓		Severity depends on 'chance', body part hit or location
018	Struck nail protruding from insert in concrete – injured arm	More serious hand / arm laceration or eye injury requiring time off		✓			Loss of sight or penetrating injury to eye			✓		Severity depends on 'chance' and body part hit
019	Struck by falling prop whilst moving tower – injured back	Dislocation or injury requiring hospitalisation			✓		Even more serious back injury or head injury leading to fatality or permanent disability				✓	Severity depends on 'chance' and body part hit
020	Fire whilst removing gas pipe – no injury	Serious injury from fire or fumes - eg requiring hospitalisation			✓		Fatalities from fire or explosion				✓	Severity depends on 'chance' and effectiveness of emergency procedures

Study No	Outcome / injury (actual)[15] (1)	Potential outcome /injury (likely)[16] (2)	1-3-days[17]	> 3-day	Major	Fatality	Potential outcome / injury (possible)[2] (3)	1-3-days	> 3-day	Major	Fatality	Comments (4)
021	Struck steel 'slither' whilst checking wagon contents – injured thumb	More serious hand laceration – possible infection requiring time off		✓			More serious injury from fall from height after injuring hand			✓		Severity depends on 'chance'
022	Crushed by plasterboard whilst removing from trolley – injured hand	More serious hand crush injury – possibly fractured finger requiring time off		✓			Hand crush injury – possibly fractured finger requiring time off		✓			Unlikely to be worse than > 3-day
023	Slipped on oil on stairs – injured elbow and hip	More serious slip injury – eg hip or knee dislocation			✓		More serious injury eg fall from height down stairs leading to fatality or permanent disability				✓	Severity depends on 'chance', location and body part hit
024	Cut self with saw whilst cutting services hanger – injured hand	More serious hand injury (eg loss of finger)			✓		More serious injury from fall from height after injuring hand			✓		Severity depends on 'chance' and location
025	Struck roofing component whilst climbing down scaffold – injured leg	More serious leg injury requiring time off		✓			Fatality from fall from height off scaffold after injuring leg				✓	Severity depends on 'chance' and location
026	Knocking in sheet pile with sledge hammer – injured back	More serious back injury / MSD requiring time off		✓			Dislocation of shoulder or other long term disability / MSD			✓		Severity depends on 'chance' and IP fitness / work history etc
027	Helmet fell off whilst bending over – cut head on stanchion	More serious head injury / laceration requiring time off		✓			Even more serious head injury - eg requiring hospitalisation			✓		Severity depends on 'chance'
028	Slip whilst unloading plywood – fractured wrist	More serious fall injury - eg requiring hospitalisation			✓		Fatality from more serious fall injury eg hit head in fall				✓	Severity depends on 'chance' and body part hit
029	Manual handling lifting forks on excavator – injured back	More serious musculoskeletal injury requiring time off		✓			Dislocation of shoulder or spine			✓		Severity depends on 'chance' and IP history / resilience
030	Knocking in sheet pile with sledge hammer – injured back	More serious back injury / MSD requiring time off		✓			Back injury leading to hospitalisation or shoulder dislocation			✓		Severity depends on 'chance' and IP fitness / work history etc
031	Struck by lorry platform whilst attaching it – hand injury	More serious hand injury – possible amputation of finger			✓		More serious hand injury or other crush injury - eg requiring hospitalisation			✓		Severity depends on 'chance' and body part crushed
032	Dropped concrete pump pipe – injured foot	More serious foot or leg crush injury requiring time off		✓			Leg or ankle fracture			✓		Severity depends on 'chance' and body part hit

Study No	Outcome / injury (actual)[15] (1)	Potential outcome /injury (likely)[16] (2)	1-3-days[17]	> 3-day	Major	Fatality	Potential outcome / injury (possible)[2] (3)	1-3-days	> 3-day	Major	Fatality	Comments (4)
033	Laying kerb – trapped and injured finger	Fracture to finger or thumb requiring time off		✓			More serious hand injury - eg requiring hospitalisation or leading to loss of finger / thumb			✓		Severity depends on 'chance'
034	Unstacking ductwork – caught and cut hand	More serious hand laceration requiring time off		✓			Laceration leading to loss of finger			✓		Severity depends on 'chance'
035	Drilling ductwork – swarf injured eye	Penetrating injury to eye			✓		Loss of sight			✓		Severity depends on 'chance'
036	Descending from access tower – caught harness and fell – fractured elbow	More serious fall injury - eg requiring hospitalisation			✓		Even more serious fall injury leading to fatality or permanent disability				✓	Severity depends on 'chance' and body part hit
037	Caught foot on cables – twisted knee	Knee dislocation			✓		Knee dislocation and additional head injury from fall			✓		Severity depends on 'chance'
038	'Jockey' wheel on bowser gave way – injured arm	More serious arm crush injury			✓		Crush fatality caused by being trapped under bowser				✓	Severity depends on 'chance' and body part crushed
039	Torquing bolts on gantry – injured back	More serious musculoskeletal injury requiring time off		✓			Shoulder or spine dislocation			✓		Severity depends on 'chance' and IP history / resilience
040	Concrete contact with ankles during pour – cement burns	More serious cement burns requiring time off		✓			Cement-related dermatitis leading to permanent disability			✓		Severity depends on exposure frequency / IP history etc
041	Vehicle caught winch cable – injured leg	More serious leg injury – eg severe laceration requiring time off		✓			Dislocation caused by winch cable – or hospitalisation			✓		Severity depends on 'chance'
042	Maintenance to boring machine – glove caught and injured wrist	Loss of finger			✓		Loss of finger / hand			✓		Severity depends on 'chance'
043	Installing cables in ceiling void – debris in eye	Penetrating injury to eye			✓		Loss of sight			✓		Severity depends on 'chance'
044	Struck by falling timber – injured arm	More serious arm injury / MSD requiring time off		✓			Fracture or other injury requiring hospitalisation			✓		Severity depends on 'chance' and body part hit

Study No	*Outcome / injury (actual)*[15] *(1)*	*Potential outcome /injury (likely)*[16] *(2)*	*1-3-days*[17]	*> 3-day*	*Major*	*Fatality*	*Potential outcome / injury (possible)*[2] *(3)*	*1-3-days*	*> 3-day*	*Major*	*Fatality*	*Comments (4)*
045	Soldering pipe – removed glasses and rubbed eye with flux on fingers – Injured eye	More serious eye injury – infection from flux etc requiring time off		✓			Loss of sight or penetrating injury to eye			✓		Severity depends on 'chance'
046	Tripped by shallow hole whilst walking across site – cut hand and twisted knee	MSD requiring time off		✓			Fracture /dislocation or hit head during fall -hospitalisation			✓		Severity depends on 'chance' and body part hit during fall
047	Fall from piling rig during maintenance operation – slight foot injury	Ankle fracture or knee / hip dislocation			✓		More serious fall injury – eg hit head during fall - requiring hospitalisation			✓		Severity depends on 'chance' and body part hit during fall
048	Laying membrane which snagged – injured shoulder	MSD requiring time off		✓			Shoulder dislocation			✓		Severity depends on 'chance' and IP history / resilience
049	Cutting cladding panels – swarf entered and injured eye	Penetrating injury to eye			✓		Loss of sight			✓		Severity depends on 'chance'
050	Manual handling bucket of tools – strained back	More serious musculoskeletal back injury requiring time off		✓			Even more serious MS injury - eg spine or shoulder dislocation			✓		Severity depends on 'chance' and IP history / resilience
051	Tripped on board - twisted thumb	Wrist fracture or shoulder dislocation			✓		Fatality from fall from height				✓	Severity depends on location
052	Struck underground cable - no injury	Fatality or at least unconsciousness from electrocution			?	✓	Fatality from electrocution				✓	Severity depends on 'chance'
053	Tripped on rubble - injured ankle	Fractured ankle or dislocated knee			✓		Fatality if fall from height				✓	Severity depends on location
054	Slipped on insulation - injured back	More serious back injury - eg requiring hospitalisation			✓		Fatality if fall from height				✓	Severity depends partly on location and partly on 'chance'
055	Fall through scaffold* (*Accident book record and IP account differ significantly)* - injured side / hand	Serious injury from fall - eg fracture or requiring hospitalisation			✓		Fatality from fall from height				✓	Lift shaft scaffold is high risk therefore strong likelihood of serious consequences

Study No	Outcome / injury (actual)[15] (1)	Potential outcome /injury (likely)[16] (2)	1-3-days[17]	> 3-day	Major	Fatality	Potential outcome / injury (possible)[2] (3)	1-3-days	> 3-day	Major	Fatality	Comments (4)
056	Lifting equipment - injured back	More serious back injury / MSD requiring time off		✓			Shoulder or spine dislocation or requiring hospitalisation			✓		Manual handling injuries often depend on IP history
057	Trapped hand (crane) -injured finger	More serious injury to hand or arm – eg loss of finger			✓		Loss of limb			✓		Craneage accident – serious potential consequences
058	5m fall through scaffold - only slight injury to leg and face	Serious injury from fall - eg requiring hospitalisation			✓		Fatality from fall from height				✓	Very likely to have serious consequences
059	Cut with saw – injured thumb	More serious injury to hand - eg hospitalisation			✓		Loss of thumb			✓		Severity depends on 'chance'
060	Trapped by falling plant – bruised side	Dislocation /fracture or hospitalisation from crush injuries			✓		Permanent disability or fatality by crushing				✓	Plant-related - Very likely to have serious consequences
061	Struck by falling cable – cut hand	Finger amputation			✓	?	Fatality if hit head				✓	Severity depends on body part hit
062	Fall from ladder – injured knee	Knee dislocation			✓		Fatality from fall from height				✓	Severity depends on height fallen etc
063	Drilling swarf – injured eye	Time off from eye injury – eg infection from swarf		✓		?	Loss of sight or penetrating injury to eye			✓		Severity depends on chance
064	Tripped on board – twisted knee	Knee dislocation			✓		Fatality if fall from height				✓	Severity depends on location
065	Struck by falling bricks – injured finger	More serious hand injury – possible loss of finger			✓		Serious head injury if materials hit head or other IP			✓		Severity depends on 'chance', location and body part hit
066	Cut hand whilst removing metal stud	More serious hand injury – possible loss of finger			✓		Even more serious hand injury or eye injury - eg hospitalisation			✓		Severity depends on 'chance' and body part hit
067	Stepped on nail in wood – injured foot	More serious foot puncture injury requiring time off		✓			Even more serious foot injury - eg requiring hospitalisation			✓		Severity depends on 'chance'
068	Struck by falsework prop – injured head	More serious head injury - eg requiring hospitalisation or fracture			✓		Even more serious head injury leading to fatality/disability				✓	Severity depends on 'chance'

Study No	*Outcome / injury (actual)*[15] *(1)*	*Potential outcome /injury (likely)*[16] *(2)*	*1-3-days*[17]	*> 3-day*	*Major*	*Fatality*	*Potential outcome / injury (possible)*[2] *(3)*	*1-3-days*	*> 3-day*	*Major*	*Fatality*	*Comments (4)*
069	Struck by formwork being lifted by crane – Injured side, back & fingers	Fracture / dislocation or head injury and unconsciousness			✓		Fatality or permanent disability				✓	Craneage accident – serious potential consequences. Severity depends on body part hit
070	Struck by paving slab – injured foot	More serious foot or leg crush injury requiring time off		✓			Ankle fracture			✓		Severity depends on body part hit
071	Electrocution – No apparent injury	Serious injury or fatality from electrocution			?	✓	Fatality from electrocution				✓	Severity depends on 'chance'
072	Struck by falling scaffold - unconscious	Fatality from head injury				✓	Fatality from head injury				✓	Severity depends on height materials fall and 'chance'
073	Tripped on rebar – bruised leg	More serious trip injury requiring time off		✓			More serious trip injury - eg requiring hospitalisation			✓		Unlikely to be 'fall from height' as groundworks operation
074	Trapped finger during 'crane-lift'	More serious hand injury - eg requiring hospitalisation			✓		Loss of limb			✓		Using forklift as crane – likely serious potential consequences
075	Tripped on rubble – injured ankle	More serious trip injury – eg fracture or dislocation			✓		Even more serious trip injury - eg requiring hospitalisation			✓		Unlikely to be 'fall from height' as groundworks operation
076	Struck rebar – injured leg	Serious leg injury / laceration requiring time off	?	✓			Serious leg injury / laceration requiring time off		✓			Unlikely to be more than > 3-day
077	Fall through scaffold – injured ribs	More serious rib / back injury - eg requiring hospitalisation			✓		Fatality from fall from height				✓	Severity depends on 'chance'
078	Struck by cable – cut face	More serious face or eye laceration requiring time off		✓			Loss of sight or penetrating injury to eye			✓		Severity depends on 'chance' and body part hit
079	Pulled against harness lanyard – injured back	Injured back / MSD requiring time off		✓			Shoulder dislocation			✓		Severity depends on 'chance'
080	Trapped finger whilst installing door	More serious finger crush injury requiring time off		✓			Possible loss of finger			✓		Severity depends on 'chance'
081	Tripped on brick on scaffold – injured ankle	Ankle fracture or knee dislocation			✓		Fatality from fall from scaffold				✓	Severity depends on location

Study No	Outcome / injury (actual)[15] (1)	Potential outcome /injury (likely)[16] (2)	1-3-days[17]	> 3-day	Major	Fatality	Potential outcome / injury (possible)[2] (3)	1-3-days	> 3-day	Major	Fatality	Comments (4)
082	Struck scaffold – injured head	More serious head injury requiring hospitalisation / loss of consciousness			✓		Fatality from fall from scaffold following head striking scaffold				✓	Helmet fell off – severity depends on possibility of falling from height
083	Cut finger handling glass	More serious hand laceration requiring time off		✓			Loss of finger or injury requiring hospitalisation			✓		Severity depends on 'chance'
084	Manual handling kerb – injured hand	More serious hand crush injury requiring time off		✓			Loss of finger or injury requiring hospitalisation			✓		Severity depends on 'chance'
085	Struck by 'JCB' – injured leg	Knee or hip dislocation			✓		Fatality from crush injuries				✓	Plant-related incident – likely serious outcomes - Severity depends on 'chance'
086	Tripped - Cut hand on steel pile	More serious hand laceration – potential infection requiring time off		✓			More serious injury (eg head) – requiring hospitalisation			✓		Severity depends on body part hit
087	Injured wrist whilst using crow bar	More serious wrist/arm injury / MSD requiring time off		✓			Shoulder dislocation			✓		Severity depends on 'chance'
088	Tripped on brick 'band' – cracked rib	Other fracture and / or head injury - loss of consciousness			✓		Other fracture and / or head injury - loss of consciousness			✓		Unlikely to be 'fall from height' as ground-level operation
089	Struck by rebar – cut head	More serious head / face / eye injury - hospitalisation			✓		Possible fall from height (lift shaft)				✓	Lift shaft location
090	Struck by falsework – cut leg	More serious leg or crush injury – eg hospitalisation			✓		Fatality from crush injury or possible fall from height				✓	Severity depends on body part crushed or location
091	Struck scaffold – cut nose	Injury requiring time off		✓			Loss of sight or penetrating injury to eye			✓		Severity depends on body part hit – Helmet reduced injury – Eye protection not worn
092	Struck ceiling trim – cut arm	More serious arm injury / laceration requiring time off		✓	?		More serious head or eye injury – eg requiring hospitalisation			✓		Severity depends on body part hit
093	Struck by falling wet concrete – injured eye	More serious eye injury eg infection requiring time off		✓			Loss of sight or other crush / impact injury if more concrete			✓		Severity depends on 'chance' (amount of concrete)

Study No	*Outcome / injury (actual)*[15] *(1)*	*Potential outcome /injury (likely)*[16] *(2)*	*1-3-days*[17]	*> 3-day*	*Major*	*Fatality*	*Potential outcome / injury (possible)*[2] *(3)*	*1-3-days*	*> 3-day*	*Major*	*Fatality*	*Comments (4)*
094	Equipment fire – burn to hand	More serious burn injury requiring time off		✓	?		Multiple fire-related fatalities				✓	Fires on construction sites have very serious consequences
095	Struck (self) with hammer – injured finger	More serious hand injury requiring time off		✓			Serious hand injury requiring time off		✓			Unlikely to be more than > 3-day
096	Struck by rolls of fabric – injured hand	More serious hand injury / MSD requiring time off		✓			Head injury having been knocked over – eg requiring hospitalisation			✓		Severity depends on 'chance' and body part hit
097	Struck (self) with hammer – injured leg	More serious leg or other limb injury requiring time off		✓			Even more serious leg injury – eg requiring hospitalisation			✓		Severity depends on 'chance'
098	Struck (self) with scraper – bruised neck	More serious neck injury / laceration requiring time off		✓			Even more serious neck or head injury – eg hospitalisation			✓		Severity depends on body part hit
099	Caught fingers in drill – broke fingers	More serious hand injury – eg requiring hospitalisation			✓		Even more serious hand injury – eg loss of fingers			✓		Severity depends on 'chance'
100	Fell through scaffold – no injury recorded	Fall injury – fracture / dislocation			✓		Fatality from fall from scaffold				✓	Severity depends on 'chance'
TOTALS		**Likely potential outcomes**	0	48	48-52	4-6	**Possible potential outcomes**	0	2	64	34	

APPENDIX D

ACCIDENT CAUSAL ANALYSIS

Accident Causal Analysis (judged as being a causal factor with 'reasonable confidence')

	worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
001 Struck by rebar tie-wire – Injured eye	✓											✓	✓				✓		✓		✓	IP not wearing eye protection, task not covered by RA/MS
002 Cut by circular saw – injured hand											✓			✓		✓	✓				✓	alternative sub-frames available that would have eliminated risk, old power saw worked in unsafe state, inadequate RA
003 Fire – No injury?																✓	✓				✓	fan protection against fire failed, RA's did not consider fire risk
004 Struck by falling prop – Injured back	✓																				✓	carpenter actions caused prop to be in an unsafe state, any RA obviously ineffective
005 Struck when dropped steel angle – Injured finger	✓	✓									✓	✓					✓		✓		✓	workers attempted to lift very heavy load, materials inappropriate for manual handling, no thought given to this in their specification
006 Ring snagged on protrusion – Injured finger															✓						✓	no hand holds to aid stepping off lift, risk assessment should have identified problems
007 Cut with knife whilst cutting board – Injured leg	✓	✓		✓																	✓	IP should not have been cutting ply with a 'Stanley' knife, not picked up by supervision or any RA

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
008	Hit self with scaffold tube – Injured foot	✓									✓					✓	✓						pipe clips dirty with concrete, concrete resistant or easy clean design should be possible
009	Struck by steel 'banding' to brick pack – Cut arm													✓								✓	plywood should be supplied with nylon straps, not picked up by any risk assessment
010	Struck by falling formwork during removal – minor injury																			✓		✓	hazardous procedure, with risk inadequately managed (including changes after incident)
011	'Hiab' delivery vehicle overturned whilst off-loading – No injury	✓	✓					✓							✓							✓	driver operated loader without stabilisers fully extended, insufficient space, neither lorry safety mechanisms nor risk assessment anticipated this eventuality
012	Struck by 'foam' ball and concrete whilst clearing concrete pump line – Groin and back injury		✓		✓										✓							✓	inadequately trained, unsupervised operative, unsafe system of work
013	Screwed through wood into finger using powered screwdriver – Injured finger							✓		✓												✓	working in a small area at an inappropriate time

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
014	Cut self with knife – Injured finger														✓							✓	obvious risk of cuts when cutting sash window cords with Stanley knife, wrong tool, no consideration of safety
015	Struck by concrete slab whilst demolishing – Cut hand	✓	✓				✓			✓												✓	inexperienced work mate dropped slap with protruding steel, awkward location, no gloves worn, needed to get job done, no consideration of safety
016	Fall from step ladder – Injured leg and elbow																✓						3 week old stepladders reckoned to be faulty, not sure this represented a safe system of work but no evidence on this
017	Tripped over cable – Injured ankle		✓				✓				✓							✓			✓	✓	trailing cable was a tolerated unsafe practice, suggestion of ankle weakness due to previous falls on site
018	Struck nail protruding from insert in concrete – Injured arm	✓			✓		✓													✓		✓	nails remaining after removal of shuttering, should have been knocked down, no local risk assessment
019	Struck by falling prop whilst moving tower – Injured back	✓	✓		✓																	✓	unsafe method of working, unsupervised, no risk assessment
020	Fire whilst removing gas pipe – No injury			✓			✓												✓				confusion in communications with utility supplier

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
021	Struck steel 'slither' whilst checking wagon contents – Injured thumb														✓		✓				✓	✓	rail wagon damaged previously by digger, no handrails, no process of equipment inspection, tolerance of damaged equipment
022	Crushed by plasterboard whilst removing from trolley – Injured hand		✓	✓											✓	✓			✓			✓	trolley design basic, quote - if the other man would have understood 'stop pushing' - may have helped - not enough labourers to help collect plasterboards so worker helped
023	Slipped on oil on stairs – Injured elbow and hip										✓				✓						✓	✓	quote - people who spilled oil should have cleared it up - they didn't and instead covered it with a piece of card, quote - oil spills out when pipe fitters move their machines upstairs!
024	Cut self with saw whilst cutting services hanger – Injured hand		✓									✓			✓			✓				✓	awkward difficult task, difficult access, difficult to do wearing PPE (glasses, gloves, helmet)
025	Struck roofing component whilst climbing down scaffold – Injured leg										✓							✓	✓		✓		time pressure, delay, quote - project overwhelmed with design revisions / variations

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
026	Knocking in sheet pile with sledge hammer – Injured back		✓												✓							✓	usually done by machinery but not possible, in a rush, doesn't do job often
027	Helmet fell off whilst bending over – Cut head on stanchion	✓							✓						✓								high risk area - overhead lines, trains, high voltage cables, helmet very uncomfortable in the heat
028	Fall whilst unloading plywood – Fractured wrist								✓						✓							✓	plastic gloves slipped over wet plywood, ground wet with leaves, raining
029	Manual handling lifting forks on excavator – injured back		✓					✓							✓				✓			✓	awkward lift, no safety training, no fork lift truck available
030	Knocking in sheet pile with sledge hammer – Injured back		✓			✓				✓					✓							✓	awkward - hitting sheet piles lower than feet level with sledgehammer, completing work of machinery, rushing to go to next job - had been working 4.5 hours without a break
031	Struck by lorry platform whilst attaching it – Hand injury		✓		✓											✓						✓	✓	awkward, difficult and heavy task, worker was helping the wagon driver, quote - safety culture fine when boss about otherwise risk taking

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
032	Dropped concrete pump pipe – Injured foot		✓		✓			✓								✓						✓	inexperienced worker helping a mate, difficult awkward task and awkward area to get into, no change in pump design in decades
033	Laying kerb – Trapped and injured finger	✓											✓		✓			✓				✓	quote - gloves hot, sweaty, uncomfortable, still get concrete burns - believes if he had worn gloves would still have damaged finger
034	Unstacking ductwork – Caught and cut hand		✓											✓				✓				✓	ductwork oily, awkward manual handling
035	Drilling ductwork – Swarf injured eye	✓										✓			✓			✓				✓	
036	Descending from access tower – caught harness and fell – Fractured elbow														✓			✓	✓			✓	quote on harness - they get in the way and I don't know why you have to wear one.
037	Caught foot on cables – twisted knee	✓				✓			✓			✓									✓		quote - the pressure to accommodate build means that housekeeping goes down (area could have been better lit and tidier)
038	'Jockey' wheel on bowser gave way – injured arm		✓			✓										✓						✓	safety officer and engineer had already identified shortcomings with the design of the jockey wheel i.e. no feedback as to whether securely engaged

	worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
039 Torquing bolts on gantry – Injured back	✓	✓												✓				✓			✓	task at awkward height and posture, quote - have fallen behind with the work - trying to get the job done as quickly as possible
040 Concrete contact with ankles during pour – Cement burns	✓	✓		✓					✓								✓				✓	concrete had been ordered and had to get the job done - deliveries were late
041 Vehicle caught winch cable – Injured leg	✓	✓	✓																		✓	one person short to look out for traffic
042 Maintenance to boring machine – Glove caught and injured wrist	✓	✓			✓				✓						✓				✓		✓	pushed for time, long hours, repetitive task using inherently dangerous machinery
043 Installing cables in ceiling void – debris in eye	✓						✓					✓					✓				✓	cable stiff to draw out and unravel - awkward task, restricted space
044 Struck by falling timber – Injured arm								✓		✓							✓			✓		
045 Soldering pipe – removed glasses and rubbed eye with flux on fingers – Injured eye	✓	✓					✓							✓			✓				✓	confined space, hard hat makes access more difficult

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
046	Tripped by shallow hole whilst walking across site – Cut hand and twisted knee		✓						✓		✓								✓				piezometer installers should have back-filled the holes, de-lineated walk paths would also help
047	Fall from piling rig during maintenance – Slight foot injury															✓	✓					✓	debate on the design of the crane running board - rails might prevent the rig from working, handrails around cab on newer machines
048	Laying membrane which snagged – Injured shoulder	✓	✓		✓	✓							✓						✓			✓	quote - should have asked for help - pressure to get things done - they want you to hurry without saying so
049	Cutting cladding panels – swarf injured eye	✓	✓						✓									✓				✓	quote – 'I imagine the Method Statement says wearing goggles and ear defenders are needed when using jigsaws!'
050	Manual handling bucket of tools – Strained back	✓	✓												✓			✓	✓			✓	trying to lift heavy bucket of tools through narrow aperture in scaffold
051	Tripped on board - Twisted thumb		✓				✓				✓										✓	✓	had to manoeuvre scaffold around bits of steel, loose brick etc
052	Struck underground cable – No injury						✓								✓	✓						✓	old cable had no markings, not found by CAT, not on electricity boards drawings

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
053	Tripped on rubble - Injured ankle									✓	✓									✓			quote - a bit behind - always more to do
054	Slipped on insulation whilst carrying scaffold - Injured back	✓							✓		✓		✓									✓	lifting scaffold tube - ethofoam should have been cleared
055	Fall through scaffold - Injured side / hand		✓						✓			✓						✓				✓	
056	Lifting equipment - Injured back		✓												✓	✓			✓			✓	heavy (40 kg when empty - full at the time) industrial vacuum cleaner pushed across site and lifted up step, quote - I know you are not supposed to lift over 25kg but don't want to appear lazy
057	Trapped hand (crane) - Injured finger	✓	✓	✓											✓							✓	correct lift puller not used, crane driver using mobile phone, put fingers in hole whilst chains lifting
058	5m fall through scaffold - Only slight injury to leg and face	✓													✓				✓			✓	confined space, complex scaffolding around beams
059	Cut with saw – Injured thumb	✓	✓												✓			✓				✓	why was he not wearing gloves?

	worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
060 Trapped by falling plant – Bruised side		✓								✓				✓	✓		✓				✓	Genie shifted and unbalanced, supported unknown weight, little chip / pebble could have tipped it over, no formal training on using the Genie
061 Struck by falling cable – Cut hand	✓	✓												✓							✓	awkward heavy task at height, not wearing gloves
062 Fall from ladder – Injured knee	✓					✓				✓								✓			✓	mud on boots, very muddy walkway, should have lane for traffic and one for walking or tarmac surface
063 Drilling swarf – Injured eye	✓	✓		✓							✓			✓			✓				✓	quote - didn't realise steel gets stuck in the eye, looking up, working above head
064 Tripped on steel plate – Twisted knee																		✓	✓		✓	setting out point not marked, no walkways, ?points put in too early
065 Struck by falling bricks – injured finger	✓	✓												✓							✓	quote - bricks are sharp - normally wears gloves but had removed them - many find gloves a hindrance
066 Cut hand whilst removing metal stud	✓	✓												✓							✓	not wearing gloves
067 Stepped on nail in wood – Injured foot	✓	✓								✓				✓							✓	quote - unsure if it was appropriate for him to wear a steel plate in the sole of the boot as he was an electrician

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
068	Struck by falsework prop – injured head	✓						✓		✓	✓								✓			✓	Prop was 'loose' - IP should not have been there
069	Struck by formwork on crane – Injured side, back & fingers			✓				✓		✓									✓	✓		✓	IP climbing ladder - formwork on crane - dangerous overlap of trades - positioning of access dubious
070	Struck by paving slab – Injured foot	✓					✓				✓			✓								✓	Paving slabs stacked and fell over
071	Electrocution – No apparent injury											✓		✓				✓				✓	Electric pumps were faulty
072	Struck by falling scaffold – Unconscious										✓				✓		✓					✓	Scaffold section loose and was knocked off platform - helmet reduced injury
073	Tripped on rebar – bruised leg						✓					✓		✓				✓				✓	rebar' protruding from concrete rubble used as hardcore
074	Trapped finger during 'crane-lift' from fork-lift	✓			✓										✓	✓				✓		✓	Use of forklift in this way is questionable
075	Tripped on rubble – Injured ankle						✓					✓		✓				✓				✓	Tripped on brick rubble used as hardcore
076	Struck rebar – injured leg						✓	✓											✓			✓	Lack of walkways to keep IP away from hazard

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
077	Fall through scaffold – Injured ribs	✓								✓						✓	✓		✓				IP may have removed scaffold boards himself and then forgot
078	Struck by cable – cut face							✓						✓								✓	Heavy armoured cable came loose - ceiling void working area is 'tight'
079	Pulled against harness lanyard – injured back	✓													✓	✓							IP forgot he had harness on - It was not needed at that stage anyway
080	Trapped finger whilst installing door	✓											✓		✓							✓	IP appeared to be doing the work in an inappropriate situation - ie not on a bench
081	Tripped on brick on scaffold – injured ankle	✓									✓								✓		✓		IP was responsible for clearing scaffold - he tripped on 'his own' rubbish
082	Struck scaffold – injured head	✓						✓							✓	✓					✓		Helmet fell off when IP bent over
083	Cut finger handling glass	✓								✓				✓	✓				✓		✓	✓	Gloves not worn
084	Manual handling kerb – Injured hand	✓	✓		✓													✓				✓	IP not accustomed to task and not trained
085	Struck by 'JCB' – Injured leg							✓											✓			✓	Plant / pedestrian zones should be separate
086	Tripped - Cut hand on steel pile							✓			✓				✓		✓		✓			✓	Top of pile damaged during installation - Gloves worn but ineffective

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
087	Injured wrist whilst using crow bar		✓												✓	✓						✓	IP provided own tools - location and position of shutter may not have been ideal
088	Tripped on brick 'band' – Cracked rib										✓			✓								✓	Brick pallet packing band was protruding from the ground
089	Struck by rebar – cut head	✓	✓		✓									✓	✓					✓			Inappropriate method being used to straighten rebar
090	Struck by falsework – Cut leg			✓							✓				✓	✓	✓				✓	✓	Trolley 'table-form' toppled - a 'common occurrence' but not addressed
091	Struck scaffold – Cut nose	✓						✓									✓				✓	✓	Scaffolding and shutter erection very close - scaffold protruding
092	Struck ceiling trim – Cut arm							✓				✓		✓				✓		✓		✓	IP working in congested ceiling void - accident was a common occurrence but not addressed
093	Struck by falling wet concrete – Injured eye			✓						✓									✓	✓		✓	Concrete pour proceeding above IP work area
094	Equipment fire – Burn to hand	✓												✓				✓				✓	Supervisor believed operatives abused the concrete breakers which may have contributed
095	Struck (self) with hammer – Injured finger	✓	✓									✓			✓								Setting out peg broke when hit

		worker actions/behaviour	worker capabilities (including knowledge/skills)	communication	immediate supervision	worker health/fatigue	site conditions (excluding equipment, materials, weather)	site layout/space	working environment (lighting/noise/hot/cold/ wet)	work scheduling	housekeeping	suitability of materials	usability of materials	condition of materials	suitability of equipment	usability of equipment	condition of equipment	permanent works design	project management	construction processes	safety culture	risk management	*comments*
096	Struck by rolls of fabric – Injured hand	✓			✓								✓						✓		✓	✓	Rolls were being stacked when they fell - Supervisor believed that this was 'horseplay'
097	Struck (self) with hammer – Injured leg	✓	✓						✓						✓								Trying to hit a timber stake and 'missed' - ground conditions may have contributed
098	Struck (self) with scraper – Bruised neck														✓	✓						✓	Scraper caught nail and struck IP - shutter being cleaned may not have been in the best location / position
099	Caught fingers in drill – Broke fingers	✓	✓												✓	✓						✓	Brushing dust away from hole whilst drilling - correct equipment not used
100	Fell through scaffold – No injury recorded																✓		✓		✓	✓	Scaffold boards moved by 'unknown persons'
	Count	49	42	7	13	5	11	15	9	11	19	12	8	13	44	19	12	27	24	12	15	84	

APPENDIX E

DESIGN PREVENTION ANALYSIS

Potential for Designers to reduce the accident risk

Study No	Outcome / injury (actual)[18]	*Permanent works design issues relating to incident*[19]	*No*[20]	*Maybe*	*Yes*	*Materials design issues relating to incident*[21]	*No*[3]	*Maybe*	*Yes*	*Temporary works design issues relating to incident*[22]	*No*[3]	*Maybe*	*Yes*	*Equipment design issues relating to incident*[23]	*No*[3]	*Maybe*	*Yes*	*Comments*
001	Struck by rebar tie-wire – Injured eye	Reduce or remove need for rebar fixing – eg by pre-assembly or by not using insitu concrete			✓	Should supplier consider tie wire storage and use on site?			✓	Establish access walkways			✓	Tie wire storage and dispensing equipment			✓	Prefabricated rebar 'mats' are available for many applications
002	Cut by circular saw – injured hand	Change design to prevent need for cutting mitres on site			✓	Pre-cut mitres			✓	Unlikely to have reduced risk	✓			Improved design of saw and guard – saw jammed			✓	

[18] Incident outcome and resultant injury summarised from accident book record and interview data.

[19] Potential issues for the permanent works designers (Architect/Engineer etc) have been developed from the accident study accounts. These are not necessarily causal factors, but are better viewed as things that designers could have done to reduce the risk. As a general comment, designers can reduce incident likelihood by removing or reducing the need to do the work on site although this may not be practicable in all instances. In some cases existing alternative, safer solutions exist (eg many pre-assembled systems), in some cases the design team may need to design or procure specialist design of safer alternatives.

[20] No/Maybe/Yes – These columns indicate the likelihood that action by the each of the designers would have actually prevented the incident.

[21] Potential issues for the materials designers (Often not directly involved in the construction design process) have been developed from the accident study accounts. These are not necessarily causal factors, but are better viewed as things that designers of materials could have done to reduce the risk. Some of the materials issues could have been specified by the permanent works designers, for others it is more likely that the materials designers themselves would be best placed to take the action themselves.

[22] Potential issues for the temporary works designers (Usually employed by the principal contractor or sub-contractor) have been developed from the accident study accounts. Temporary works cover, in particular scaffolding and formwork/falsework. These are not necessarily causal factors, but are better viewed as things that TW designers could have done to reduce the risk. It is recognised that some of these interventions would require a significant re-orientation of the traditional TW design approach.

[23] Potential issues for the tool or equipment designers (not usually directly involved in the construction design process) have been developed from the accident study accounts. These are not necessarily causal factors, but are better viewed as things that tool or equipment designers could have done to reduce the risk.

Study No	*Outcome / injury (actual)*	*Permanent works design issues relating to incident*	*No*	*Maybe*	*Yes*	*Materials design issues relating to incident*	*No*	*Maybe*	*Yes*	*Temporary works design issues relating to incident*	*No*	*Maybe*	*Yes*	*Equipment design issues relating to incident*	*No*[3]	*Maybe*	*Yes*	*Comments*
003	Fire – No injury?	Design for demolition / decommissioning to avoid need for cutting up of elements on site			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Fan and filter design to reduce fire risk			✓	
004	Struck by falling prop – Injured back	Reduce or remove need for insitu concrete		✓		Unlikely to have reduced risk	✓			Falsework – design props to be restrained during striking			✓	Unlikely to have reduced risk	✓			
005	Struck when dropped steel angle – Injured finger	Reduce size & weight of angle – Design cladding support as part of structure			✓	Should angle supplier have taken action to facilitate manual handling?		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
006	Ring snagged on protrusion – Injured finger	Unlikely except to reduce on-site work	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Equipment design to remove snag risks			✓	
007	Cut with knife whilst cutting board – Injured leg	*Remove need to cut board on site – eg pre-assembly or pre-cut boards to suit toilet pan*		✓		Should board supplier specify cutting method?		✓		Unlikely to have reduced risk	✓			Knife design		✓		Site work because of flexibility needed in refurbishment
008	*Hit self with scaffold tube – Injured foot*	Unlikely except to reduce on-site work – eg insitu concrete	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Concrete pump pipe design – especially couplings		✓		
009	Struck by steel 'banding' to brick pack – Cut arm	Unlikely except to reduce on-site work – eg brickwork	✓			Alternative packaging method			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
010	Struck by falling	Reduce or remove		✓		Unlikely to have	✓			Re-design		✓		Unlikely to have	✓			

Study No	Outcome / injury (actual)	Permanent works design issues relating to incident	No	Maybe	Yes	Materials design issues relating to incident	No	Maybe	Yes	Temporary works design issues relating to incident	No	Maybe	Yes	Equipment design issues relating to incident	No[3]	Maybe	Yes	Comments
	formwork during removal – minor injury	need for insitu concrete				reduced risk				formwork to prevent falling during removal				reduced risk				
011	'Hiab' delivery vehicle overturned whilst off-loading – No injury	Unlikely except to reduce on-site work – Perhaps building footprint may have exacerbated tight space	✓			Alternative delivery method – but this may have generated other risks	✓			Unlikely to have reduced risk	✓			Prevent off-loading unless stabilisers fully extended			✓	
012	Struck by 'foam' ball and concrete whilst clearing concrete pump line – Groin and back injury	Reduce or remove need for insitu concrete		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Re-design pump clean out technique			✓	
013	Screwed through wood into finger using powered screwdriver – Injured finger	Canteen work not part of PW design brief	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Safety cut out on screw-driver		✓		Work to site canteen
014	Cut self with knife – Injured finger	Design for demolition to remove need for cutting		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Better knife design – Better glove design		✓		
015	Struck by concrete slab whilst demolishing – Cut hand	Design for demolition – risk assessment		✓		Unlikely to have reduced risk	✓			Temporary support during demolition			✓	Better hand protection?		✓		
016	Fall from step ladder – Injured leg and elbow	Unlikely	✓			Unlikely to have reduced risk	✓			Appropriate work platform design		✓		Step-ladder design			✓	
017	Tripped over cable	Remove or reduce			✓	Unlikely to have	✓			Unlikely to have	✓			Unlikely to have	✓			

Study No	Outcome / injury (actual)	Permanent works design issues relating to incident	No	Maybe	Yes	Materials design issues relating to incident	No	Maybe	Yes	Temporary works design issues relating to incident	No	Maybe	Yes	Equipment design issues relating to incident	No[3]	Maybe	Yes	Comments
	– Injured ankle	need for on-site installation of brickwork or power cable – eg pre-assembly				reduced risk				reduced risk				reduced risk				
018	Struck nail protruding from insert in concrete – Injured arm	Remove or reduce need for insitu concrete work – Specify post-drilled fixings		✓		Alternative fixing for inserts to avoid need for protruding nails			✓	Formwork design to produce 'fail-safe' insert fixing			✓	Unlikely to have reduced risk	✓			But post-drilled fixings also bring other hazards
019	Struck by falling prop whilst moving tower – Injured back	Remove or reduce need for insitu concrete		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
020	Fire whilst removing gas pipe – No injury	Design for demolition – risk assessment		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
021	Struck steel 'slither' whilst checking wagon contents – Injured thumb	Unlikely	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Improved glove design?		✓		
022	Crushed by plasterboard whilst removing from trolley – Injured hand	Unlikely except reduce on-site work (plasterboard)	✓			*Should plasterboard supplier provide suitable trolley?*		✓		Unlikely to have reduced risk	✓			*Plasterboard trolley design*			✓	*However, plasterboard typically has less site work than alternatives*
023	Slipped on oil on stairs – Injured elbow and hip	Unlikely except reduce site work	✓			Unlikely to have reduced risk	✓			Access stair design		✓		Unlikely to have reduced risk	✓			
024	Cut self with saw	Reduce site fixed			✓	Re-design hanger			✓	Unlikely to have	✓			Saw design		✓		

Study No	Outcome / injury (actual)	Permanent works design issues relating to incident	No	Maybe	Yes	Materials design issues relating to incident	No	Maybe	Yes	Temporary works design issues relating to incident	No	Maybe	Yes	Equipment design issues relating to incident	No[3]	Maybe	Yes	Comments
	whilst cutting services hanger – Injured hand	above ceiling services by pre-assembly - Re-design hanger system (SC design)				system				reduced risk				Alternative tool for cutting ceiling hangers Improved glove design				
025	Struck roofing component whilst climbing down scaffold – Injured leg	Reduce need for built-up roofing system (lots of site cutting etc)			✓	Unlikely to have reduced risk	✓			Scaffold design interface with roof works		✓		Unlikely to have reduced risk	✓			
026	Knocking in sheet pile with sledge hammer – Injured back	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Alternative to manual installation of sheet piles			✓	Produce alternative tool for manual installation		✓		
027	Helmet fell off whilst bending over – Cut head on stanchion	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Improved helmet design to encourage use and prevent 'fall off'			✓	
028	Fall whilst unloading plywood – Fractured wrist	Unlikely except reduce general on-site work	✓			Consideration of manual handling of ply sheets		✓		Unlikely to have reduced risk	✓			Improved glove grip in wet weather			✓	
029	Manual handling lifting forks on excavator – injured back	Unlikely except reduce general on-site work	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Improved design of excavator forks especially when changing			✓	
030	Knocking in sheet pile with sledge hammer – Injured back	Unlikely	✓			Unlikely to have reduced risk	✓			Alternative to manual installation of sheet piles			✓	Unlikely to have reduced risk	✓			
031	Struck by lorry	Unlikely except	✓			Change materials		✓		Unlikely to have	✓			Change platform			✓	

Study No	Outcome / injury (actual)	Permanent works design issues relating to incident	No	Maybe	Yes	Materials design issues relating to incident	No	Maybe	Yes	Temporary works design issues relating to incident	No	Maybe	Yes	Equipment design issues relating to incident	No[3]	Maybe	Yes	Comments
	platform whilst attaching it – Hand injury	reduce on-site work – possible building footprint impact on working space				design to ease off-loading				reduced risk				design to fail-safe				
032	Dropped concrete pump pipe – Injured foot	Reduce insitu concrete		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Lifting hold-points on concrete pump pipes – design for manual handling			✓	
033	Laying kerb – Trapped and injured finger	Change kerb design to reduce MH risk			✓	Change kerb design to reduce MH risk			✓	Unlikely to have reduced risk	✓			Improve mechanical handling equipment		✓		
034	Unstacking ductwork – Caught and cut hand	Reduce insitu ductwork			✓	Ductwork design to reduce sharp edges			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
035	Drilling ductwork – Swarf injured eye	Reduce insitu ductwork			✓	Ductwork design to reduce need to drill			✓	Unlikely to have reduced risk	✓			Drill guards to protect against swarf?		✓		
036	Descending from access tower – caught harness and fell – Fractured elbow	Reduce insitu M&E services			✓	Unlikely to have reduced risk	✓			Access tower design (platform height, handrail solution in restricted areas			✓	Harness design to reduce 'catch' risk		✓		Access to ceiling zone as continually problematic
037	Caught foot on cables – twisted knee	Unlikely except reduce general on-site work	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
038	'Jockey' wheel on bowser gave way – injured arm	Unlikely except reduce general on-site work	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Jockey wheel design			✓	
039	Torquing bolts on	Unlikely except	✓			Unlikely to have	✓			Gantry design			✓	Torquing tool			✓	

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	gantry – Injured back	reduce general on-site work				reduced risk								design				
040	Concrete contact with ankles during pour – Cement burns	Specify non-hazardous cement or reduce insitu concrete			✓	Cement suppliers to produce cost-effective 'safer' cement			✓	Unlikely to have reduced risk	✓			Better design of boots to increase effective use			✓	German use of cement that doe not cause dermatitis
041	Vehicle caught winch cable – Injured leg	Unlikely except reduce general on-site work	✓			Unlikely to have reduced risk	✓			Traffic management plans?		✓		Winch cable arrangements			✓	
042	Maintenance to boring machine – Glove caught and injured wrist	Unlikely except reduce work on site	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Better access for maintenance – Better glove design			✓	
043	Installing cables in ceiling void – debris in eye	Remove or reduce need for work in ceiling void – eg pre-assembly / modular wiring looms			✓	Produce value for money modular wiring systems			✓	Unlikely to have reduced risk	✓			Improve eye protection design to increase use			✓	
044	Struck by falling timber – Injured arm	Remove / reduce on-site work at height – eg ad-hoc cutting of timber			✓	Unlikely to have reduced risk	✓			Formwork design to reduce need for cutting on site			✓	Unlikely to have reduced risk	✓			
045	Soldering pipe – removed glasses and rubbed eye with flux on fingers – Injured eye	Remove or reduce need for on-site joints in pipework – eg pre-assembly or solder-free joints			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Improve eye protection to increase use – prescription safety glasses?			✓	Glasses were prescription not PPE
046	Tripped by shallow	Unlikely except	✓			Unlikely to have	✓			Access walkways			✓	Unlikely to have	✓			

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	hole whilst walking across site – Cut hand and twisted knee	reduce work on site				reduced risk								reduced risk				
047	Fall from piling rig during maintenance – Slight foot injury	Unlikely except reduce work on site – Difficult for this work element	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Provide safe access for plant maintenance			✓	Even pre-assembled piles need rigs to install them
048	Laying membrane which snagged – Injured shoulder	Unlikely except reduce work on site – Difficult for this work element	✓			Have manufacturers considered MH issues?		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
049	Cutting cladding panels – swarf injured eye	Remove or reduce need to cut cladding on site (particularly at height) – eg easier to control pre-assembly off-site or at ground level			✓	Materials design to reduce need to cut on site			✓	Unlikely to have reduced risk	✓			Cutting equipment – guard to protect from swarf – better eye protection to increase use			✓	
050	Manual handling bucket of tools – Strained back	Reduce on-site required at height – eg pre-assembly of cladding			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Provide effective and transportable tool container		✓		
051	Tripped on board - Twisted thumb	Design to ensure MH cover is installed along with structure		✓		Unlikely to have reduced risk	✓			More effective temporary covers to manholes to remove trip hazard			✓	Unlikely to have reduced risk	✓			
052	Struck underground cable - No injury	Design to avoid other cables		✓		Cable design to reduce injury risk			✓	TW designer could have had clearer role		✓		Improve brief to cable detector to reduce misuse			✓	Temp water main is PC responsibility not PW designer
053	Tripped on rubble -	Unlikely except	✓			Unlikely to have	✓			Unlikely to have	✓			Unlikely to have	✓			

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	Injured ankle	reduce on-site work in general				reduced risk				reduced risk				reduced risk				
054	Slipped on insulation whilst carrying scaffold - Injured back	Design to avoid or reduce need for scaffold		✓		Insulation used in this way – have slip hazards been considered?		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
055	Fall through scaffold - Injured side / hand	Design to avoid or reduce need for scaffold – e.g. pre-assembled lift-shafts			✓	Unlikely to have reduced risk	✓			Scaffold design to prevent removal of boards and hence prevent fall hazard			✓	Unlikely to have reduced risk	✓			Pre-assembled lift shafts remove need for shaft scaffolds. Some modular scaffold systems make ad-hoc board removal harder
056	Lifting equipment - Injured back	Unlikely except reduce on-site work in general	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Try transparent vacuum 'bag' or 'full' indicator - suitable hand holds - warnings			✓	
057	Trapped hand (crane) -Injured finger	Unlikely except reduce on-site work or check building footprint for adequate working space	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Crane and lifting tackle design to prevent hand trap			✓	
058	5m fall through scaffold - Only slight injury to leg and face	Design to avoid or reduce need for scaffold		✓		Unlikely to have reduced risk	✓			Scaffold design to prevent removal of boards and hence prevent fall hazard			✓	Unlikely to have reduced risk	✓			Some modular scaffold systems make ad-hoc board removal harder
059	Cut with saw –	Design to avoid or			✓	Produce alternative		✓		Unlikely to have	✓			Saw design – guard			✓	

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	Injured thumb	reduce need for site cutting of trunking				trunking that does not require site cutting				reduced risk				/ safety features?				
060	Trapped by falling plant – Bruised side	Original design method developed for removal of ductwork			✓	Weights marked on all installed elements		✓		Unlikely to have reduced risk	✓			Stability of lift and fail-safe solution if overloaded			✓	
061	Struck by falling cable – Cut hand	Original design method developed for removal of cables	✓			Weights marked on installed elements – Bracket design to fail-safe		✓		Original TW design method developed for splicing and removal of cables		✓		Unlikely to have reduced risk	✓			Cable possibly temp supply, therefore PC's responsibility
062	Fall from ladder – Injured knee	Unlikely except reduce on-site work in general	✓			Unlikely to have reduced risk	✓			Better access ways			✓	Improved ladder design to cope with mud			✓	
063	Drilling swarf – Injured eye	Design to remove or reduce need to site-drill steelwork			✓	Self-drilling screw design to prevent swarf propulsion			✓	Unlikely to have reduced risk	✓			Better designed eye protection to encourage use			✓	
064	Tripped on board – Twisted knee	Unlikely – setting out points not PW design issue	✓			Unlikely to have reduced risk	✓			Better access way - Covers to setting out points to remove trip hazard			✓	Unlikely to have reduced risk	✓			
065	Struck by falling bricks – injured finger	Unlikely except reduce on-site work by pre-assembling brickwork	✓			Unlikely to have reduced risk	✓			Provide loading platforms to scaffold			✓	Better design of brick-carrying device to retain bricks – better glove design			✓	
066	Cut hand whilst removing metal stud	Unlikely except reduce on-site work in general	✓			Studwork design to reduce cut risk		✓		Unlikely to have reduced risk	✓			Better glove design to encourage use		✓		
067	Stepped on nail in	Unlikely except	✓			Unlikely to have	✓			Unlikely to have	✓			Better boot design		✓		

Study No	Outcome / injury (actual)	Permanent works design issues relating to incident	No	Maybe	Yes	Materials design issues relating to incident	No	Maybe	Yes	Temporary works design issues relating to incident	No	Maybe	Yes	Equipment design issues relating to incident	No[3]	Maybe	Yes	Comments
	wood – Injured foot	reduce on-site work in general				reduced risk				reduced risk				to encourage use				
068	Struck by falsework prop – injured head	Remove or reduce on-site work using falsework (ie insitu concrete)		✓		Unlikely to have reduced risk	✓			Falsework design to reduce risk of prop falling			✓	Prop design to ensure correctly secured			✓	
069	Struck by formwork on crane – Injured side, back & fingers	Remove or reduce insitu concrete - or check building footprint for adequate working space		✓		Unlikely to have reduced risk	✓			Better access ways – Protected stair access not ladders			✓	Unlikely to have reduced risk	✓			
070	Struck by paving slab – Injured foot	Unlikely except reduce on-site work in general	✓			Paving slab design to aid storage and manual handling		✓		Unlikely to have reduced risk	✓			Improved boot design or selection		✓		
071	Electrocution – No apparent injury	Design such that electrical work could not have been installed incorrectly – ie fail-safe			✓	Heating pump design in error			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
072	Struck by falling scaffold - Unconscious	Unlikely except reduce on-site work in general	✓			Unlikely to have reduced risk	✓			Scaffold design			✓	Better helmet design		✓		
073	Tripped on rebar – bruised leg	Consider appropriateness of re-cycled hardcore specification		✓		Recycled hardcore 'design'		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Reinforced concrete rubble used as hardcore may have provided hazard
074	Trapped finger	Unlikely except	✓			Unlikely to have	✓			Unlikely to have	✓			Appropriateness of			✓	

Study No	Outcome / injury (actual)	Permanent works design issues relating to incident	No	Maybe	Yes	Materials design issues relating to incident	No	Maybe	Yes	Temporary works design issues relating to incident	No	Maybe	Yes	Equipment design issues relating to incident	No[3]	Maybe	Yes	Comments
	during 'crane-lift' from fork-lift	reduce on-site work - or check building footprint for adequate space				reduced risk				reduced risk				fork-lift in 'crane' mode				
075	Tripped on rubble – Injured ankle	Consider appropriateness of re-cycled hardcore specification		✓		Recycled hardcore 'design'		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Re-cycled hardcore (brick rubble) may have been key factor
076	Struck rebar – injured leg	Reduce formwork (ie insitu concrete) – Possibly design column starter bars to avoid trip hazard		✓		Unlikely to have reduced risk	✓			Established access ways			✓	Unlikely to have reduced risk	✓			Starter bar protruding is a standard detail
077	Fall through scaffold – Injured ribs	Remove or reduce on-site work using scaffolding		✓		Unlikely to have reduced risk	✓			Scaffold design to prevent removal of boards and hence prevent fall hazard			✓	Unlikely to have reduced risk	✓			Some modular scaffold systems make ad-hoc board removal harder
078	Struck by cable – cut face	Remove or reduce need to install large cables on site – perhaps by pre-assembly		✓		Design of cable reels and cable stability during installation		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
079	Pulled against harness lanyard – injured back	Unlikely except remove or reduce on-site work using scaffolding	✓			Unlikely to have reduced risk	✓			Scaffold design to reduce need for harnesses in erection		✓		Harness design to reduce risk		✓		
080	Trapped finger whilst installing door	Design to remove need for lock installation on-site		✓		Lock design to aid installation		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
081	Tripped on brick on	Unlikely except	✓			Unlikely to have	✓			Unlikely to have	✓			Unlikely to have	✓			

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	scaffold – injured ankle	remove or reduce on-site work using scaffolding or insitu brickwork				reduced risk				reduced risk				reduced risk				
082	Struck scaffold – injured head	Unlikely except reduce on-site work in general	✓			Unlikely to have reduced risk	✓			Scaffold design to reduce head injury risk		✓		Better helmet design to prevent 'fall-off'		✓		
083	Cut finger handling glass	Unlikely except reduce on-site work in general	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Better glove design or selection		✓		
084	Manual handling kerb – Injured hand	Reduce kerb weight / Provide hand-holds			✓	Kerb design to ease manual handling – weight / hand holds			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
085	Struck by 'JCB' – Injured leg	Unlikely except reduce on-site work - or check building footprint for adequate space	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Suitability of excavator as lifting equipment – lifting points for compressor		✓		
086	Tripped - Cut hand on steel pile	Unlikely except reduce on-site work in general	✓			Pile design to remove cut risk			✓	Unlikely to have reduced risk	✓			Better glove design or selection		✓		
087	Injured wrist whilst using crow bar	Unlikely except reduce on-site work (insitu concrete in particular)	✓			Unlikely to have reduced risk	✓			Formwork design to reduce site alterations			✓	Crow bar design		✓		
088	Tripped on brick	Unlikely except	✓			Review banding to		✓		Unlikely to have	✓			Unlikely to have	✓			

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	'band' – Cracked rib	reduce on-site work in general				brick packs				reduced risk				reduced risk				
089	Struck by rebar – cut head	Unlikely except reduce on-site work (insitu concrete lift shaft in particular)	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Design or selection of equipment to straighten rebar		✓		
090	Struck by falsework – Cut leg	Unlikely except reduce on-site work (insitu concrete in particular)	✓			Unlikely to have reduced risk	✓			Table-form design, especially for moving			✓	Unlikely to have reduced risk	✓			
091	Struck scaffold – Cut nose	Unlikely except reduce on-site work (insitu concrete in particular) - or check building footprint for adequate space	✓			Unlikely to have reduced risk	✓			Scaffold design to prevent protruding elements			✓	Unlikely to have reduced risk	✓			
092	Struck ceiling trim – Cut arm	Pre-assembled ceiling services avoid need for above ceiling access			✓	Design ceiling trim to reduce sharp edges – modular wiring reduces site work		✓		Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
093	Struck by falling wet concrete – Injured eye	Unlikely except reduce on-site work in general (insitu concrete in particular)	✓			Unlikely to have reduced risk	✓			Formwork and scaffold design to prevent concrete falling			✓	Unlikely to have reduced risk	✓			
094	Equipment fire – Burn to hand	Remove or reduce need for concrete breaking			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Breaker design to prevent fire risk – fail-safe			✓	Unsure if the task was due to contractor's error or design change
095	Struck (self) with	None	✓			Unlikely to have	✓			Unlikely to have	✓			Hammer design for		✓		

Study No	*Outcome / injury (actual)*	*Permanent works design issues relating to incident*	*No*	*Maybe*	*Yes*	*Materials design issues relating to incident*	*No*	*Maybe*	*Yes*	*Temporary works design issues relating to incident*	*No*	*Maybe*	*Yes*	*Equipment design issues relating to incident*	*No*[3]	*Maybe*	*Yes*	*Comments*
	hammer – Injured finger					reduced risk				reduced risk				human interaction				
096	Struck by rolls of fabric – Injured hand	None	✓			Design of rolls to facilitate site storage			✓	Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			
097	Struck (self) with hammer – Injured leg	None	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Hammer design for human interaction		✓		
098	Struck (self) with scraper – Bruised neck	Unlikely except reduce on-site work (insitu concrete in particular)	✓			Unlikely to have reduced risk	✓			Review formwork design to reduce site cleaning requirement		✓		Scraper design for human interaction			✓	
099	Caught fingers in drill – Broke fingers	Unlikely except reduce on-site work (insitu concrete in particular)	✓			Unlikely to have reduced risk	✓			Unlikely to have reduced risk	✓			Drill design – better glove design or selection			✓	
100	Fell through scaffold – No injury recorded	Unlikely except remove or reduce on-site work using scaffolding	✓			Unlikely to have reduced risk	✓			Scaffold design to improve platform safety			✓	Unlikely to have reduced risk	✓			
	TOTALS	**Permanent works design**	53	22	25	**Materials design**	65	18	17	**Temporary works design**	64	10	26	**Equipment design**	40	25	35	

APPENDIX F

DISTAL FACTOR ANALYSIS

Accident 1 – Carrying tying wire

The end of the tying wire snagged and sprung back into the operative's eye. A standard construction method was being used. There are alternative methods of construction, eg pre-cast concrete or pre-fabrication of rebar, that would have avoided the task being undertaken (carrying rebar tying wire). This is a design issue but would require detailed understanding of the construction process and risk factors, by the designer, to consider objectively. There are also alternative ways of holding/dispensing and carrying the wire, which would have avoided the particular danger encountered, a design of materials handling and task issue.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; Designer (of building) response; training; construction feedback into design; design of equipment and methods.

Accident 2 – Mitre cutting for window sub-frame

An innovative construction method of window installation, to avoid scaffolding (for cost reasons), was introduced by contractor with designer agreement. It resulted in an avoidable site joinery task, during which the circular saw safety guard jammed, and a hand injury. The designer was not familiar with the construction requirements of this type of site work when making the decision, but it is unlikely that this would have changed his decision.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; designer response; design of equipment.

Accident 3 – Angle grinder sparks ignited fan filter

Sparks, from the use of an angle grinder in an enclosed space, caused ignition of the filter in an extractor fan. Inadequate RA and MS – failed to recognise and take account of this particular fire risk. There is insufficient data to speculate as to the reasons.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; RA/MS failure.

Accident 4 – Acrow prop fell during stripping formwork

An 'Acrow' prop was not supported or removed before stripping formwork and fell on a scaffolder working in the same area. There was an inappropriate construction method and conflict of two activities, resulting in congestion; plus failure by carpenter to follow work procedures. There was inadequate supervision but no real evidence of time pressure.

Possible distal factors: inappropriate construction control; inappropriate construction operation; inappropriate operative action; training; supervision.

Accident 5 – Dropped steel angle, trapping hand, while moving it into new position

Poor design of construction method – excessive size/weight of steel components – combined with inadequate manual handling methods. PS denied responsibility for MS/RA.

Possible distal factors: inappropriate construct planning; inappropriate construction operation; MH training.

Accident 6 - Caught wedding ring on protrusion

Wearing of jewellery (ring) while working resulted in it snagging on a protrusion on a scissor lift and caused lacerations. Design of equipment (access to the scissor lift) was also implicated.

Possible distal factors: inappropriate operative action; inappropriate construction operation; training; supervision; design of plant.

Accident 7 – Cutting ply with Dolphin knife

An operative was cutting ply with a small open bladed knife, towards himself. This resulted in a cut leg. Inappropriate construction operation – tool ('Dolphin' knife) was provided by employer and used in a dangerous cutting method.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; inappropriate operative action; tool selection; training.

Accident 8 – Trying to connect concrete pump line

Trying to close a dirty clamp onto a concrete pipe joint resulted in foot injury. Poor equipment design and/or maintenance caused problems in making the joint in the concrete pipe. There was careless use of scaffold tube as a 'hammer', possibly due to lack of proper tools, conveniently to hand.

Possible distal factors: inappropriate construction operation; inappropriate operative action; lack of appropriate tools; training.

Accident 9 – Cutting steel banding on bundle of new ply

Cutting steel banding caused the recoil of the band and injury to an arm. It was an inappropriate construction operation – two person task – using an inadequate tool (cutters). Materials packaging design (steel banding) is conducive to this type of risk during unpacking. Manufacturers had made a RA but this was not accounted for in site activity planning.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; inappropriate tool; inadequate RA and/or training.

Accident 10 – Struck formwork fell through hole in floor

Formwork being struck fell through a hole in a concrete floor and straight through a matching hole in the next floor, dislodging a protective ply cover on the way. Inappropriate construction operation – release of formwork over a hole – combined with inadequate protection (weak ply) of the hole on the next floor.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; training; RA/MS; design of hole protection.

Accident 11 – Hiab lorry tipped over

A 'Hiab' delivery lorry tipped over due to failure to use stabilising legs while unloading in a confined space. Work planning (co-ordination) issues were inadequately covered in the MS. There are also plant design (safety) issues.

Possible distal factors: inappropriate construction planning; inappropriate construction control; inappropriate construction operation; training; supervision.

Accident 12 – Hit by foam ball during blowing out of concrete pipeline

Operative hit by foam ball, discharged under pressure from concrete pipeline when cleaning out. Inappropriate construction method during concrete pipe blow-out. Lack of task training. Lack of adequate supervision. Inadequate RA dissemination and training.

Possible distal factors: inappropriate construction operation; inappropriate operative action; MS/RA; training; supervision.

Accident 13 – Electric screwdriver went through wood into finger

Using electric drill as screwdriver, without sufficient concentration, resulted in penetration of wood and injury to a finger. There was difficulty with interruption from people walking by and lack of space. Possibly, the workspace could have been designed better – e.g. cordoned off during task execution. No evidence of lack of training.

Possible distal factors: inappropriate construction planning; inappropriate operative action; workspace design; congestion.

Accident 17 – Trip over cable while carrying equipment

This was a typical trip accident on a loose electric cable, probably caused by lack of training in trip hazards for supervision and management and lack of clear responsibility for management of temporary cabling.

Possible distal factors: inappropriate construction planning; inappropriate site condition; safety training; unclear responsibilities.

Accident 18 – Caught arm on shuttering nail left protruding

This was due to failure to remove a nail from partially stripped formwork and possible design failure in work method or formwork construction, to avoid nail hazard. MS/RA was not used on this task (even if relevant). There was also a possible excessive hours issue (tiredness/lack of concentration) due to moonlighting (3-4 hours/d).

Possible distal factors: inappropriate site condition; inappropriate construction planning; method design; RA communication.

Accident 19 – Prop to falsework frame fell while moving frame

Careless sequencing of task activity resulted in an unstable prop to falsework; and the prop fell onto an operative. There was also a possible issue of inadequate RA communication.

Possible distal factors: inappropriate construction operation; task sequencing; inappropriate construction control; training/supervision in relation to RA.

Accident 20 – Cutting out (live!) gas main

Incorrect information about a live gas main resulted in ignition of gas during cutting of main to remove it. There was an inappropriate procedure during removal of the gas main. There was also no RA or MS for a potentially very dangerous task.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; communication; work method/procedure; RA/MS.

Accident 21 – Inspecting contents of rail wagon

A supervisor hurt his hand on the damaged edge to a wagon, while climbing the outside in order to inspect contents. There was poor design of access to view the wagon contents, due to either wagon design or method design. The wagon condition was potentially dangerous. There was also high time pressure and excessive hours being worked.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; inappropriate operative action.

Accident 22 – Crushed hand while pushing plasterboard trolley

The IP's hand was injured by crushing against an unprotected scaffold nut, while pushing a fully loaded plasterboard trolley. He was being assisted by a foreign labourer, with whom there were language communication problems. Careless use of the trolley, an unprotected scaffold clip and inadequate materials handling methods are all implicated.

Possible distal factors: inappropriate construction operation; language difficulty; materials handling; scaffolding/housekeeping.

Accident 24 – Cut thumb while cutting threaded stud in ceiling erection

A different construction method could have avoided the need to cut the rod. Task, cutting tool and cutting method could all have been designed differently.

Possible distal factors: designer response; inappropriate construction planning; inappropriate construction operation.

Accident 33 – Trapped finger between kerb block and stone bed

This is a manual handling injury in which a finger was crushed between a heavy kerb and the stone bed during positioning of the kerb. Training, supervision and PPE issues are evident. Gloves were not worn due to heat and discomfort. There are possible design of task/materials interface issues in task method.

Possible distal factors: inappropriate construction operation; inappropriate operative action; training; PPE selection/use.

Accident 34 – Hand slipped from steel ducting

IP's hand-hold on ducting slipped on its oily surface, while attempting to release it from inside another piece of ducting, resulting in banging his hand on adjoining ducting stack. Gloves were not worn – too restrictive. Possible task/component/material design issues related to manual handling – there was little design/production liaison.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; training; PPE selection/use; task and material design.

Accident 35 – Swarf in eye while drilling ductwork

Electric drilling caused a swarf injury to IP's eye – no goggles worn. There are possible material/task design issues, as well as PPE design/comfort issues.

Possible distal factors: inappropriate construction planning; inappropriate operative action; task design; PPE.

Accident 36 – Banged elbow on part of hatch on mobile access scaffold

Harness which was unhooked got caught while descending scaffold tower – possible PPE design issue. Harness would not have been required if the scaffold tower design had been flexible enough to accommodate ceiling shape. There were also design of access tower hatch and possible building design/task access issues.

Possible distal factors: inappropriate construction planning; inappropriate construction operation; PPE; scaffold tower design.

Accident 37 – Trip over cables led to knee injury

Trip hazard on temporary power supply cables led to a twisted knee injury. There are clear housekeeping and workplace design issues. The knee was already weak from a previous injury suggesting a health surveillance aspect.

Possible distal factors: inappropriate construction planning; inappropriate site condition; housekeeping; workplace design; health surveillance.

Accident 38 – Bowser jockey wheel collapse

An inadequately clamped jockey wheel on a fuel bowser collapsed when the bowser was being moved, causing a wrench strain to arm and shoulder. Jockey wheel design, plant design and specification could have been improved. There are also care in operation and training issues. The injury exacerbated an old shoulder injury, suggesting a health surveillance aspect.

Possible distal factors: inappropriate construction planning; inappropriate operative action; plant design/specification; training; health surveillance.

Accident 39 - Torquing 'Robello' ring on gantry

Maintenance, checking and correcting the torque, on part of a gantry required heavy activity in an awkward position (bending). The equipment (slewing ring) was used in the wrong context – possibly specified incorrectly for such a piece of plant (gantry). The torquing process was being done by someone unused to the activity and in a difficult posture.

Possible distal factors: inappropriate construction planning; inappropriate operative action; equipment design; task design.

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