Improving health and safety in construction
Phase 2 - Depth and breadth

Volume 1 - Summary report

This report presents an illustrated summary of a major investigation into the underlying causes and risk controls for a range of construction activities. The work has sought to combine hard data, including accident and ill-health evidence, with 'expert' judgements to build up a comprehensive and balanced understanding of the human, hardware and external factors.

The research has utilised an Influence Network (IN) to provide structured insight to the immediate and underlying organisational, policy or contextual factors through the supply chain affecting work on site. Diverse problems have been examined including: hand-arm vibration syndrome; construction transport safety (for roadworks, plant, and goods delivery); falls from height (in new-build construction and maintenance of existing structures); and an industry-wide view considering the potential efficacy of different intervention mechanisms HSE might adopt in working with the industry.

The findings from ten workshops, involving a wide range of industry practitioners, are consolidated in this report. There is strong belief that influence from the regulator on clients and contractors to integrate explicit recognition of health and safety in the culture, in contracting strategies and through safety management can encourage emphasis on appropriate site management/supervision, whilst ensuring designers playing their part in reducing the risks to which workers are exposed. These organisational improvements in training, selection of safe working methods and strengthening of the health & safety culture, are seen to lead on to greater awareness of the risks, individual understanding of the controls and competence to comply and work safely, which should have a direct impact on improving health and safety in construction.

The consistency and the robustness of the IN ‘data’ and interpretations, suggest it can be a useful tool for application on specific sites and as a framework for benchmarking and for monitoring the success of improvement programmes.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.
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EXECUTIVE SUMMARY

This research was prompted by the need to take an holistic view of the circumstances leading to accidents and ill-health in the construction industry to find practicable solutions. This view needed to extend beyond the equipment used and the situation of individual cases, to capture the wider human and organisational factors affecting sites and the industry in general. This major piece of research, undertaken by BOMEL Limited, was sponsored by the Health and Safety Executive (HSE) and the Association of British Insurers (ABI).

The underpinning philosophy of the project was to identify as wide a range of intelligence sources as possible and to organise the information in such a way that it can be used to both provide insight and understanding to specific issues and to inform a future improvement and risk control strategies. A fundamental challenge is that hard data exist for some aspects of construction health and safety but in other areas (in relation, for example, to health issues or underlying human factors causes of accidents) the conventional evidence is incomplete.

The solution was to supplement hard data with expert judgements gathered in a structured way to ensure the findings were balanced and representative. BOMEL’s Influence Network (IN) technique was adopted (see Figure 1) for this purpose and, ten industry workshops, all primed with evidence from hard data sources and drawing on a wealth of industry practitioner experience, explored different aspects of construction activity.
Principal areas of risk for construction workers formed the focus of the workshops. *Falls from height* were examined in the context of new-build construction and, by contrast, in maintenance type activity on existing structures. Distinct circumstances associated with *construction transport accidents* in the construction context were also examined in terms of plant operations, roadworks and goods delivery.

Three sessions on *hand arm-vibration syndrome* (HAVS) in the ABI funded part of the study were particularly successful, serving not only to test the IN application to a health issue revealing significant new risk controls, but also to demonstrate the robustness of the IN technique and the findings delivered when adopted by different groups, with a different facilitator, but he same IN toolkit and subject matter.

Finally, HSE Inspectors took an overview of construction industry activity as a whole and, within that, considered the potential routes and efficacy of different intervention mechanisms at their disposal.

Each workshop and post-event analysis enabled *critical factors* to be identified which, by dint of the standards of performance and/or their weight of influence on other factors, mean that improvements should have a relatively significant impact on overall levels of health and safety. Similarly, *critical paths of influence* were identified through the network where coordinated action, systematically addressing critical factors through the chain, should bring considerable performance improvements.

The outputs from the project as a whole comprise:

- The BOMEL RIDDOR data tool which enables notified accidents information to be interrogated rapidly to provide detailed insight to different accident kinds or trade-related risks.

- A consolidation of other data sources to amplify understanding of accident causation beyond that available via RIDDOR.

- Detailed evidence from practitioner experts about factors influencing specific ill-health and accident scenarios covering:
  - HAVS
  - Plant operations
  - Roadworks
  - Goods delivery to site
  - Falls from height in new-build construction
  - Falls from height in maintenance / refurbishment work on existing structures
  - Scenarios with high frequency occurrence of fatal falls
  - An industry wide assessment of health and safety risks

- ‘Risk registers’ examining the construction *practices / processes* leading to specific hazards arising together with potential risk controls identified through the workshops and subsequent analysis of the IN
• Recommendations for risk controls to be effected by different supply chain parties in each of the areas, selected for their potential to make a more significant impact (based on IN analysis) than other options being considered.

• A generic ‘toolkit’ style IN for wider application.

These outputs are outlined in this *project summary report* but details are contained within companion report volumes. Within this volume the assessment of IN factors across the range of construction applications has been consolidated. This assessment suggests that actions along the paths of influence and critical factors in Figure 1 are those with the potential to bring the most significant improvements in construction health and safety overall. This notwithstanding, the individual areas of study also reveal very important additional areas for control specific to the scenarios under consideration.

Overall the work has demonstrated the IN to be an effective technique for providing holistic and systematic analysis of construction problems enabling risk control solutions to be identified and providing a framework for benchmarking practice or monitoring improvement.

Recommendations focus on the benefits of extending the IN application in this way and developing more detailed understanding of the way market factors such as insurance interact with construction business decisions and the dimensions within client / project culture and safety management systems through which improvement can be effected.
1. INTRODUCTION

1.1 BACKGROUND

This report has been prepared by BOMEL Limited for the Construction Division of the Health and Safety Executive under a research contract (RSU reference 4362/R64.089), and describes a wide-ranging study of health and safety in construction addressing priority aspects of the work programme.

The research summarised in this report comprises Phase 2 of the project ‘Improving Health and Safety in Construction’. This project follows on from the successful completion of a Phase 1\(^{(1)}\) which trialled an Influence Network technique as the basis for understanding the organisational and human factors influencing the health and safety of workers in the construction industry. The approach not only provided new insight into the interrelation of the influences between the parties involved, but it also offered a mechanism for identifying areas where improvements will be effective in reducing risk and for evaluating their potential effectiveness.

The Phase 1 trial focused specifically on fatal falls from height with two principal strands to the study. Detailed analysis of the accident data from HSE’s RIDDOR database provided insight into the risk profile which then informed an Influence Network workshop in which an expert group assessed the quality and importance of some 30 underlying risk influencing factors. Phase 1 demonstrated the value of the technique both for understanding the underlying causes of accidents and for developing strategies to bring about improvements in health and safety performance.

One of the objectives of Phase 2 was to ensure robustness of the technique as an active tool for safety improvement. Priority areas identified for scrutiny in Phase 2 were fall-related accidents, workplace transport safety and health effects of hand-arm vibration. The Phase 2 approach was to combine ‘data’ gathering and Influence Network workshops in each priority area, to provide a basis for active and demonstrable improvements in health and/or safety.

HSE and the Association of British Insurers (ABI) have provided the funding for Phase 2; the ABI specifically funded the work on hand-arm vibration syndrome.

Phase 2 specifically addressed the following complementary issues:

1. Validation of the Influence Network technique to ensure that the representation of the construction industry interactions is robust and the quantification of risk and risk control effectiveness is appropriate across the range of practices and stakeholders.

2. Application of the technique to a wider set of health and safety issues in construction than Phase 1, to see if common themes can be identified and/or to reveal factors specific to individual accident / activity types.

3. Extension of the use of the Influence Network technique from providing insight into the factors influencing the incidence of accidents and ill-health, to additionally determining effective risk control measures and improvements.
4. Identification of information categories that could usefully be collected as supplements to the RIDDOR reporting process and / or in the course of HSE investigations.

5. Use of the Influence Network approach to develop a model of the ways in which HSE’s interventions contribute to health and safety of the workforce, as a basis for helping in the development of strategies and plans and for monitoring effectiveness.

6. Focus on key issues within the construction priority programme as examples, so that the Phase 2 research forms an integral part of the Construction Division’s work.

7. Underpinning of the work with a thorough and comprehensive understanding of ‘data’ and information held by HSE and within the industry on accidents and ill-health, to give a sound and robust basis for HSE to use in other aspects of its work.

In order to address these issues, the work was divided into a number of work packages reported as follows:

Volume 1 Construction health and safety Phase 2: Summary Report

Volume 2 RIDDOR data analysis

Volume 3 Workplace transport accidents - Underlying causes and risk control

Volume 4 Hand Arm Vibration Syndrome - Underlying causes and risk control

Volume 5 Falls from height - Underlying causes and risk control

Volume 6 Generic model for health and safety in construction

Volume 7 Analysis of HSE intervention mechanisms

This report constitutes Volume 1 of the series. It provides a summary of the work undertaken within Phase 2 and a synthesis of the findings from the parallel work streams. It should be noted that each of the subsequent volumes (2 to 7) constitutes a standalone report for the reader with particular interest in the different aspects. The Executive Summaries within each volume provide an overview of the scope and findings and these are reproduced as appendices to this report (Appendices B to G respectively).

1.2 CONTEXT OF THE STUDY

In June 2000 the Deputy Prime Minister and the Health and Safety Commission (HSC) launched the Revitalising Health and Safety (RHS) Strategy Statement[2]. Underpinning this were the new targets for health and safety in the UK given in Table 1. The HSC also invited Advisory Committees to set targets for their industries. The Construction Industry Advisory Committee[3] (CONIAC) responded by setting more stringent targets for the construction industry. These are shown in Table 1 alongside the RHS targets.
Table 1  Revitalising health and safety (RHS) and CONIAC targets for health and safety

<table>
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<tr>
<th>Target</th>
<th>By 2004/5</th>
<th>By 2009/10</th>
</tr>
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<tbody>
<tr>
<td>Reduction in incidence rate of fatalities and major injury accidents</td>
<td>-5%</td>
<td>-40%</td>
</tr>
<tr>
<td>Reduction in incidence rate of cases of work-related ill-health</td>
<td>-10%</td>
<td>-20%</td>
</tr>
<tr>
<td>Reduction in number of working days lost per 100,000 workers from work related injury and ill-health</td>
<td>-15%</td>
<td>-20%</td>
</tr>
</tbody>
</table>

In October 2000, the HSC established eight ‘Priority Programmes’ within its Strategic Plan\(^4\). One of these priority programmes is Construction. The decision acknowledged the high risk facing construction workers, with the industry contributing around 33% of the fatal injury accident numbers over the previous five years and around 16% of the major injury accidents. A significant reduction in construction accidents and injuries would therefore make a large contribution to achieving the Revitalising targets. Other of the priority programmes relate to the generic accident categories of falls from height and workplace transport, both of which will be seen to present particularly high risks in construction.

It was in this context that the present research examined some of the larger contributors to construction risks and sought to identify measures which could have a significant impact on improving the health and safety of those working in the construction industry.

1.3  SCOPE OF WORK AND APPROACH

The research approach is summarised in Figure 2. Underpinning the approach is recognition that whilst ‘data’ in the form of notified accident records provide an important reference baseline, it is inevitably limited in relation to the practical aspects of construction and gives negligible insight to associated human and organisational factors. The work therefore combined a thorough review of accident data and other data sources with a series of industry workshops in which wider aspects influencing the occurrence of accidents or incidence of ill-health were considered in specific construction contexts.

In order to facilitate comparisons and to enable hard data and rich judgements to be combined, a structured, semi-quantitative approach was adopted for the workshops based around the Influence Network (IN) shown in Figure 3. The IN, described further in Appendix A, covers human, hardware and external factors and for each, current practices and standards can be described and rated against a scale ranging from best to worst conceivable practice. Furthermore the relative weighting of factors on each other can be judged so that the chain of influence, whether from environmental conditioning factors or corporate policies, can be traced through the work organisation to the factors impacting directly on the health and safety of construction workers.
Figure 2 Elements of the Phase 2 research programme

Figure 3 Generic Influence Network for construction
An important aspect of the workshops (Figure 2) was that the realities of the specific construction issues could be addressed (e.g. dependencies on scale of the project, life-cycle phase, skill levels involved, intensity of human/equipment activity, alternative working methods etc). This meant that practical and appropriate risk controls were identified, either directly through the structured discussions or indirectly prompted by analysis of the IN weightings and ratings to indicate critical paths for reducing accident/ill-health levels. Beyond the focused recommendations, however, use of a consistent and methodical approach enabled common issues to be identified which have wide ranging influence over many aspects of construction health and safety.

In order for HSE as the regulator to maximise its impact on influencing improvements in construction, it was also important to consider the intervention mechanisms at its disposal and the effectiveness of these, both with different stakeholders and in tackling the various issues identified through the data analysis and industry workshops. Taking the same IN model (Figure 3) and mapping the impact of the different intervention mechanisms, enabled the effectiveness of risk-control/intervention combinations to be assessed for the different construction issues. The research output therefore provides information both for those in industry and the HSE for working together in pursuit of improved construction health and safety.

Whilst the work has focused on high priority / high risk aspects of construction, many other areas remain to be tackled. The deliverable has therefore included a generic toolkit demonstrating how the IN in Figure 3 can be customised and the technique applied to different problems. Furthermore, although beyond the scope of this Phase 2 project, additional tools have now been developed by BOMEL for HSE to enhance the use of the core Phase 2 intelligence. Figure 4 demonstrates how these disparate and complementary information sources can be combined in developing effective evidence-based intervention strategies.

![Diagram](image)

**Figure 4** Interaction between ‘data’ sources and research techniques in option appraisal and strategy development (* = tools developed beyond Phase 2)
1.4 LAYOUT OF THIS REPORT

The purpose of this report is to explain the work carried out and the achievements in terms of prioritising effective action on construction health and safety. Whilst it summarises the findings and recommendations in the specific areas of scrutiny (falls, workplace transport and HAVS) and draws out common issues for construction in general, it is the separate reports (Volume 2 to 7) which contain the detailed insight. By way of transition, Appendices B to G, reproduce the Executive Summaries from the companion volumes. Appendix A documents the basis of the Influence Network methodology used as the framework for gathering and analysing the evidence within this research.

The layout of the main report reflects the project structuring illustrated in Figure 2.

Section 2 contains a summary of the data available to the HSE through the RIDDOR reporting system, and describes the BOMEL RIDDOR Data Tool developed to allow rapid and thorough analyses of that data to be undertaken. The basis for identifying the priority health and safety issues for scrutiny in subsequent aspects of the project is shown.

The ‘data’ aspects of the research went beyond the notified accident data and Section 3 demonstrates the way in which a range of alternative sources were used to improve the profiling of the problems.

The approach to gathering practitioner insights through the workshops is outlined in Section 3.4 in order to set the scene for the application of the Influence Network in the following sections.

Hand-arm vibration syndrome (HAVS) is the main health issue that has been addressed in this project, and the key findings are discussed in Section 5. The two main safety issues, construction transport and falls from height, are discussed in Sections 6 and 7 respectively. Construction health and safety, as perceived from some HSE perspectives, is discussed in Section 8.

The previous four sections are drawn together in Section 9 where themes emerging as being pertinent across a wide range of construction activity are highlighted. These translate into high level recommendations for the industry and regulator.

As Sections 5 to 9 essentially present conclusions in specific areas, Section 10 focuses on findings in relation to the study approach and recommendations for further enhancement and wider application.
2. RIDDOR CONSTRUCTION DATA TOOL DEVELOPMENT

Accidents and cases of work-related ill-health are notifiable under the RIDDOR regulations\(^5\). In relation to construction activity, reported accident numbers have been around 14,500 per annum over the last six years with just under 70% being classified as over three day injuries, just over 30% major injuries and less than 1% having fatal consequences. The Labour Force Survey\(^6\) indicates that around 52% of non-fatal construction industry accidents are actually reported (1999/2000 figures); this compares favourably with the corresponding all-industry average of 44%. Whilst there may be bias arising from those constructors more or less likely to report under RIDDOR, the dataset is considered sufficiently representative by the authorities to profile construction accidents.

The construction data notified under RIDDOR are coded within HSE’s FOCUS database system with categories covering SIC industry (e.g. construction - plumbing), Year (e.g. 1999/2000), Accident kind (e.g. high fall), Severity (e.g. major injury), Occupation (e.g. roofer), Work process (e.g. roofing), Agent (e.g. roofedge), Age (group), Employment status (e.g. self-employed), Region (e.g. Home Counties) etc. Where accidents are investigated by HSE, further information is held in terms of deficiency codes and Inspector investigation reports.

A change occurred in Spring 2001 since when RIDDOR notifications have been made to a central Incident Contact Centre rather than HSE offices. At the same time a change in categorisations in relation to accident kinds, work processes and agents was introduced affecting the degree to which statistical comparisons pre-and post-2001 can be made. However, notifier comments are included electronically with the new system - an advance over earlier practice.

All this data is held within HSE’s bespoke FOCUS system and used by its statisticians in profiling workplace accidents. To extend its use for the purposes of the present study, and those of the Construction Division more generally, a RIDDOR data tool was developed by BOMEL. This was based on a text format export of data from the HSE system and extensive re-structuring in a relational Microsoft Access database from which Microsoft Excel pivot charts were generated for detailed interrogation. The data manipulations were carefully validated against published statistics and a User’s Manual and System Reference Guide were prepared as Volume 2.

Table 2 profiles the construction accident data held in the data tool as applied throughout this Phase 2 research. An update to bring in provisional 2002/3 figures and finalised figures for the earlier years is in hand following publication of the official statistics in November 2003.

Represented graphically within the data tool pivot charts (Figure 5), the year on year data can be examined with a complementary tabulated format provided (Figure 6). Any of the fields can then be interrogated rapidly using the drop down list boxes to examine, for example, the pattern of accidents experienced by roofers in terms of severity and the associated agents etc (Figure 7 and Figure 8). The flexibility of the tool, the rapidity with which the data can be examined and the visual elements, have offered powerful new insight.
Table 2  Fatal, major and over 3-day injury accidents involving workers in the UK construction industry as reported via RIDDOR between 1996/97 and 2001/02

<table>
<thead>
<tr>
<th>Year</th>
<th>Fatal injury accidents</th>
<th>Major injury accidents</th>
<th>Over 3-day injury accidents</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996/97</td>
<td>90</td>
<td>4,054</td>
<td>9,666</td>
<td>13,810</td>
</tr>
<tr>
<td>1997/98</td>
<td>80</td>
<td>4,326</td>
<td>10,265</td>
<td>14,671</td>
</tr>
<tr>
<td>1998/99</td>
<td>65</td>
<td>4,656</td>
<td>9,576</td>
<td>14,297</td>
</tr>
<tr>
<td>1999/00</td>
<td>81</td>
<td>4,749</td>
<td>10,502</td>
<td>15,332</td>
</tr>
<tr>
<td>2000/01*</td>
<td>105</td>
<td>4,663</td>
<td>9,786</td>
<td>14,554</td>
</tr>
<tr>
<td>2001/02*</td>
<td>79</td>
<td>4,475</td>
<td>9,562</td>
<td>14,116</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>26,923</td>
<td>59,357</td>
<td>86,780</td>
</tr>
</tbody>
</table>

* - Provisional

Figure 5  Pivot chart showing the number of fatal, major and over 3-day injury accidents in construction in each of the last six years

Figure 6  Pivot Table showing the number of fatal, major and over 3-day injury accidents in construction in each of the last six years (corresponding to the Pivot Chart in Figure 5)
Figure 7  Pivot Chart showing the number of fatal, major and over 3-day injury accidents in construction in each of the last six years involving roofers.

Figure 8  Pivot Chart showing the number of fatal and major injury accidents in construction in each of the last six years involving roofers by accident agent.
Alternative formats have enabled the prevalence of specific accident kinds as they affect different workers to be scrutinised as shown in Figure 9. A key finding emerging from this Phase 2 work in relation to falls is that for many trades falls are the predominant cause of injury. However, many of the trades (e.g. plumbers, plasterers etc) are not necessarily associated with work at height, nor might conventional training have paid much attention to managing the associated risks.

![Figure 9: Percentage of accidents involving falls for various occupations](image)

The basic tool provides the ability to interrogate any of the coded fields within the database. When examining falls this is straightforward as these are a defined accident kind. In relation to construction transport and the surrounding safety issues, the demarcation is less clear and accident kinds such as ‘struck by’, agent types such as ‘dumper’ or occupations such as ‘goods driver’ may all indicate some association with vehicle use. A facility was therefore developed within MS Access to define a combination of codes, any of which may imply some relation to construction transport, and to carry over a single switch to the MS Excel pivot charts. Subsidiary datasets were developed in this way to identify ‘Roadwork’, ‘Plant’, and ‘Goods delivery’ aspects of construction transport. These features have added to the power, efficiency and consistency with which the risks associated with aspects of construction activity can be examined.

Where Figure 5 presents the overall construction accident profile, Figure 10 shows the pattern of falls with time and Figure 11 the corresponding information for the newly defined construction transport case. Together these account for almost half the accidents in construction and an even larger proportion, relatively, of accidents with severe consequences. From within the transport cases, three subsidiary datasets which are significant contributors to the overall profile are considered in Figure 12, Figure 13 and Figure 14.
Figure 10  Pivot Chart showing the number of fatal, major and over 3-day injury accidents involving falls from height in construction

Figure 11  Construction transport accidents between 1996/97 and 2001/02 by HSE year
Figure 12  Highways-related fatal, major and over-three-day injury accidents between 1996/97 and 2001/02

Figure 13  Fatal, major and over three-day injury goods-related accidents between 1996/97 and 2001/02 by HSE year

Figure 14  Plant-related fatal, major and over three-day injury accidents between 1996/97 and 2001/02 by HSE year
The individual reports on falls and construction transport accidents (Volumes 5 and 3) drill further into the data and examine the apparent discontinuity with the coding change in 2001. A distinct observation however, has been that where the number of options available within a category has increased, there may be more confusion / ambiguity when the case is coded leading to less reliable statistics. By contrast, fewer, simpler categories are more straightforward to code and, whilst the richness of data may be reduced, the robustness may be greater. Achieving an appropriate balance, perhaps with a hierarchy of coding options, needs to be an explicit part of any redesign of the RIDDOR notification system.

An additional feature within the database elements of the BOMEL tool which can compensate for broad categorisations, is the ability to search free text entries providing the Notifier’s description of recent accidents and Inspectors’ reports of cases investigated. For example this enabled accidents described as having some association with ‘lifting’ to be identified even though this is not a defined work process category.

Development and application of the BOMEL RIDDOR data tool developed in this project, has therefore marked a significant advance in the degree to which HSE Project Officers are able to interrogate past accident data. Each area of construction activity examined within this Phase 2 study is underpinned by a report on the analysis of the corresponding data. In addition, much of the material was used to open the workshop sessions, defining the topics to be addressed and stimulating considerable discussion amongst the participants of other related factors, outwith the coverage of the data categories.
3. USE OF OTHER CONSTRUCTION DATA REFERENCE SOURCES

3.1 BACKGROUND

Whilst Section 2 has shown the value of analysing accident records reported under the RIDDOR regulations, profiling is inevitably incomplete given the broad remit of this all-industry legislation. An important part of this project was to supplement the RIDDOR records with data and information from other sources. Three principal issues were tackled:

- Aspects of performance where RIDDOR reporting levels are particularly low or inconclusive – in this case the ill-health effects of HAVS
- The need for safety or ill-health problems to be seen in the industry context – by referencing regulations, guidance (from industry as well as HSE) and work processes through which the hazards arise.
- To expand the understanding of accident circumstances by providing more detail on recurring factors as well as information about human and organisational factors beyond the RIDDOR coding scheme.

The need for and availability of supplementary data varied with the accident or ill-health issues being addressed, although a common approach was adopted in seeking information in each case.

This section provides some examples of the information gathered in the various phases of the project, demonstrating the significant insight beyond basic accident data that can be obtained.

3.2 ALTERNATIVE DATA TO QUANTIFY HAVS IN CONSTRUCTION AND SUPPLEMENT INCOMPLETE RIDDOR REPORTING

HAVS and related carpal tunnel syndrome (CTS), as with many health issues, may be suffered after a period of exposure to vibration dependent on intensity. Gradual effects may be more difficult to recognise than an accident and the association with an employer, from both perspectives, may be less clear. Factors like these mean that the level of notification under RIDDOR may be low and insufficient for the problem to be measured meaningfully. Furthermore the latency period obviates the level of reporting being a sensitive indicator of any success in bringing improvement.

Alternative sources examined, included HSE research by the Medical Research Council\(^7\) estimating exposure levels. Figure 15 presents the estimates of the number of workers with weekly exposure above the HSE threshold / action level (of 2.8m/s\(^2\)) in different areas of industry. Similarly, by examining records within the Department for Work and Pensions’ (DWP) industrial injuries disablement benefits scheme (IIDB), all-industry numbers for newly diagnosed cases could be compared with RIDDOR values. For 1999/2000 RIDDOR reported values of 207 for CTS and 845 for HAVS compare with 468 and 3290 under the IIDB scheme, despite apparently more restrictive ‘eligibility’ definitions in the IIDB case.
Figure 15  Number of workers exposed per week to significant vibration by sector \(^{(7)}\)

Figure 16 presents IIDB claims relating to VWF in construction with the percentage ratings, indicating the degree of disability at the time the case is presented. The DWP definitions were found to make eligibility for many construction workers uncertain, nevertheless the data indicated the source of a potentially useful indicator. Raising awareness of HAVS will almost certainly increase the number of claims. Nevertheless, if with time the severity of symptoms at the point the case is first presented reduces, this could be a positive indicator with recognition being seen as the first step leading to risk controls to prevent deterioration.
3.3 INDUSTRY CONTEXT IN WHICH TO INTERPRET RIDDOR DATA

Each area of study within this Phase 2 research is reported in the context of a catalogue of the prevailing regulations and available guidance, whether from HSE in support of regulations or from industry groups, trade associations, institutions etc.

Taking an international perspective was also useful enabling the style and coverage to be compared and contrasted. In relation to work at height as a generic issue, the common focus worldwide was on construction and particularly roof work, with risk controls centred around hardware controls such as edge protection, roof ladders, mobile platforms and PPE. Nevertheless, Australian guidance was found to give more explicit attention to management controls and recognition of human factors issues, providing a useful alternative resource (see Volume 5).

To address further the context in which accidents or damage to health can arise, each hazard (work at height, vehicle movements, use of vibrating tools) was considered. This examined the type of construction work leading to exposure, the reasons such work is carried out and the potential controls available within the risk reduction hierarchy from elimination through to mitigations.

Table 3, Table 4 and Table 5 present examples from each hazard area, although the reader is referred to the relevant report volume in each case for the comprehensive tables.

**Table 3** Selection of construction work processes that use vibrating tools from Vol.4

<table>
<thead>
<tr>
<th>Work process</th>
<th>Reason</th>
<th>Alternatives / Risk controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Superstructures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete placing</td>
<td>Fresh concrete requires vibration to allow it to flow around the reinforcement and to expel air.</td>
<td>Self-compacting concrete</td>
</tr>
<tr>
<td>Concrete finishing</td>
<td>Occasionally it is necessary to finish the surface of concrete for aesthetic or functional reasons. For instance an exposed aggregate finish may be required, the surface needs cleaning before a coating is applied or an existing coating needs to be removed.</td>
<td>Use retarding admixtures for exposed aggregate finishes.</td>
</tr>
<tr>
<td>Concrete jointing</td>
<td>In order to ensure that the next pour of concrete bonds adequately with the previous one, it is necessary to remove the laitance (weak cement mortar) from the surface to expose a rough surface that to which the new concrete is more likely to bond and achieve adequate shear transfer. This is typically done using a scabller.</td>
<td>Use a retarder to delay the set of the surface concrete and remove the top few millimetres of the cement mortar with a standard pressure washer. Alternatively use an expanded metal formwork liner.</td>
</tr>
<tr>
<td>Formwork fabrication</td>
<td>Formwork needs to be cut to the correct shape of the member.</td>
<td>Use more standardised precast concrete members or standardised formwork systems</td>
</tr>
<tr>
<td>....</td>
<td>.....</td>
<td>Etc.</td>
</tr>
</tbody>
</table>
### Table 4  Selection of construction work that uses plant and vehicles from Vol. 3

<table>
<thead>
<tr>
<th>Work process</th>
<th>Reason</th>
<th>Alternatives / Risk controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Highway-related activities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road repairs</td>
<td>Repair to worn out carriageways in order to provide drivers with a safe running surface. Typically carried out from within roadworks.</td>
<td>Use longer life wearing courses in order to minimise the amount of repair and maintenance required (in balance with other constraints such as noise and spray).</td>
</tr>
<tr>
<td>Bridge inspection</td>
<td>Periodic inspection to ensure that the bridges remain in a reasonable condition. Often carried out from ‘touching distance’ whereby the use of MEWPS or other access platforms is required.</td>
<td>Carry out, where possible, outside times of peak traffic flow. Design bridges for easy inspection access.</td>
</tr>
<tr>
<td>Road widening</td>
<td>Required to increase traffic flow. Essentially construction of a new carriageway adjacent to the original.</td>
<td>Use of appropriate roadworks. Where possible design new roads with the potential for widening in mind.</td>
</tr>
<tr>
<td>Bridge maintenance and repairs</td>
<td>Required to maintain safety and/or extend service life of bridges.</td>
<td>Design bridges for durability in order to minimise the amount of repair and maintenance required.</td>
</tr>
<tr>
<td>.....</td>
<td>.....</td>
<td>etc</td>
</tr>
</tbody>
</table>

### Table 5  Selection of construction work that involves work at height from Vol. 5

<table>
<thead>
<tr>
<th>Work process</th>
<th>Reason</th>
<th>Alternatives / Risk controls</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New-build – Mechanical, electrical and fit-out work</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant installation - roof</td>
<td>Installation of air-conditioning, heating, water or electrical plant</td>
<td>Incorporate the plant within the structure (however, this does reduce the usable area). Locate away from roof-edge.</td>
</tr>
<tr>
<td>Plant installation - internal</td>
<td>Installation of air-conditioning, heating, water or electrical plant</td>
<td>Design control &amp; maintenance systems to allow access from floor level.</td>
</tr>
<tr>
<td>Plastering</td>
<td>Cover walls with a finish suitable for decorating.</td>
<td>Use wall construction methods that allow paint to be applied directly.</td>
</tr>
<tr>
<td>Carpentry</td>
<td>Partitions, doors etc.</td>
<td>Open plan. Carry out as much work as possible at ground level.</td>
</tr>
<tr>
<td>Electrical cables and fittings</td>
<td>Distribution of services to workstations.</td>
<td>Incorporate in floor voids rather than ceiling voids.</td>
</tr>
<tr>
<td>Access shafts</td>
<td>Distribution of services.</td>
<td>Provide permanent staging.</td>
</tr>
<tr>
<td>Plumbing – pipes and fittings</td>
<td>Distribution of services.</td>
<td>Provide direct service runs that require min. work at height. Pre-route conduits</td>
</tr>
<tr>
<td>Painting and decorating</td>
<td>Provide decorative and protective finishes.</td>
<td>Use members that are ready finished and require little in situ painting.</td>
</tr>
<tr>
<td>Ceilings</td>
<td>Installation of false ceilings, and services within ceiling voids.</td>
<td>Consider exposed soffits with services routed in floor voids.</td>
</tr>
<tr>
<td>Facades</td>
<td>Installation of glazing and cladding.</td>
<td>Consider buildability in the design / specification of glazing and cladding.</td>
</tr>
<tr>
<td>.....</td>
<td>.....</td>
<td>etc</td>
</tr>
</tbody>
</table>
3.4 EXPANDED DATA TO PROVIDE BROADER UNDERSTANDING OF CAUSAL FACTORS THAN CAPTURED UNDER RIDDOR

Although RIDDOR focuses on basic categorisation of accidents, much work has been done within HSE to examine aspects of specific problems. By drawing such studies into this project and providing a synthesis with basic accident data and, later, practitioner views, provided for a wider interpretation.

Two studies in relation to construction transport provide complementary examples. In the first\(^{(8)}\) a Specialist Inspector studied the investigation reports from plant-related accidents 1986-1996. Figure 17 shows the primary and secondary reasons for accidents involving dump trucks, in the ten-year period under consideration, indicating a particular problem with drivers being injured due to dump trucks with their engines running being knocked into gear whilst the driver was getting in or out.

![Figure 17: Primary and secondary reasons found for investigated accidents involving dump trucks between April 1986 and April 1996](image)

A more general study\(^{(9)}\) on workplace transport, analysed returns from a special pro-forma completed during incident investigations by HSE Inspectors 1999 to 2001. This sought to achieve a structured and consistent categorisation, capturing human and organisational factors that may have contributed to the accidents but that would not have been picked up systematically in the basic RIDDOR reporting and coding. The insight can be illustrated with Figure 18 which shows that the principal workplace factors in the 83 construction transport accidents analysed (of the 577 all-industry pro-formas) were 'ground conditions' and 'gradient of traffic routes' where more than one factor could be associated with each investigated case.

The main behavioural factors identified in the construction transport accidents are shown in Figure 19. It can be seen that 'driving without due care/attention', 'not following established systems of work' and 'selection of an inappropriate route' emerge as significant contributors.
(The study also revealed that in the majority of these cases it was felt that the problem stemmed from a violation of known rules more than a lack of knowledge – more details can be found in Volume 3).

**Figure 18** Influence of workplace factors on 83 construction transport accidents – number of cases where factor was significant

**Figure 19** Influence of behavioural factors in 83 investigated construction transport accidents – number of cases where factor was significant
3.5 CONCLUSION

With reference to Figure 4, it can be seen how combining accident data with insight from research reports, investigation findings and others sources, helps in building a risk register of factors affecting accidents in different areas of construction activity.
4. GATHERING PRACTITIONER INSIGHT USING THE INFLUENCE NETWORK

4.1 THE NEED FOR PRACTITIONER INSIGHT

The data and information sources described in the previous sections are extremely informative but the evidence relates largely to immediate causes of accidents or incidences of ill-health. In order to understand more about the underlying factors and particularly to identify routes to effect improvement, it is necessary to take account of the real context in which construction work takes place considering the people, the organisational structures and commercial context etc. In the absence of hard data on these factors, practitioner expertise provides an alternative source of intelligence. It is important that reliance is not placed on anecdote and an approach is needed which ensures rigorous and systematic treatment is given to the full range of potential issues. The Influence Network (IN) attempts to achieve this.

4.2 THE ROLE OF THE INFLUENCE NETWORK

The IN was introduced in Section 1.3 and Figure 3 and is described in detail in Appendix A. Principal features of the IN are that it:

• Combines consideration of human, hardware and external factors
• Considers direct and underlying influences on performance
• Facilitates structured discussion on the possible factors affecting safety in relation to a specific risk scenario under consideration
• Enables performance to be rated against a clearly defined scale from worst to best practice
• Distinguishes the weight of a factor’s influence from its quality.

4.3 INFLUENCE NETWORK SESSION OUTPUTS

The IN is generally used in a workshop session with particular care taken to ensure a breadth of views is represented with facilitation to balance the discussions. Direct outputs from a workshop therefore comprise:

• A detailed narrative about aspects of performance for the particular construction health or safety issue being considered; this serves both to explain the issues and anchor subsequent assessments in the prevailing views
• Supporting rating of these factors, in some cases given as a range with ‘typical’ value bounded by best and worst ratings observed in specific circumstances
• Independent assessment of the weight of influence from underlying factors
• Suggested areas for risk control arising through structured discussion or with respect to examples of good practice.

4.4 THE POTENTIAL OF INFLUENCE NETWORK ANALYSIS AND IDENTIFICATION OF RISK CONTROLS

Analysis of the material following the workshop enables the weightings and ratings to be combined to highlight:

• An overall ‘risk’ index (on a scale of 0 to 1 across the range of conceivable practice from worst to best) against which relative improvements can be assessed

• Critical influences where unit improvements in performance have greatest impact on improving the overall index

• Critical paths of influence where improvements in specific factors through different levels of the network have relatively significant impact in improving the overall index.

These can then be reviewed in light of the qualitative workshop findings, knowledge of the industry context and specific recognition of the cost, time and efficiency of interventions that HSE, for example, might consider (see Volume 7 for more information). Specific risk control measures can then be identified with more detailed planning in relation to the timing and extent of change in specific influences that can be anticipated for the resource being expended.

4.5 PROJECT WORKSHOPS

This approach has been taken in ten construction workshops in the course of this project (one of which took place as the Phase 1 pilot). The topics addressed are listed below with the corresponding appendix / companion report volume identified where more details can be found:

• Hand Arm vibration syndrome (Appendix D, Report Volume 4)
  • Three workshops on ostensibly the same topic to test the robustness of findings with different ‘expert’ groups and facilitators

• Construction Transport (Appendix C, Report Volume 3)
  • Goods delivery (and in particular associated falls)
  • Plant
  • Roadworks

• Falls from height (Appendix E, Report Volume 5)
  • Fatal falls from height considering, for example, scaffolding activity
  • New build construction (e.g. primary structural erection)
  • Existing structures (e.g. maintenance and repair)

• Generic mechanisms and HSE perspectives giving an overview of health and safety in construction (Appendix F, Report Volume 6)
Each workshop involved six to ten industry practitioners drawn from the following, with skills and experience related to the topic, as appropriate:

- Contractors (large and small)
- Trade associations
- Industry Training bodies
- Designers
- Facilities managers / Construction clients
- Medical specialists (e.g. for HAVS)
- Other Government Departments (e.g. Highways Agency)
- Equipment manufacturers
- HSE field inspectors and specialists.

4.6 IN VALIDATION

An important aspect (described particularly in Volume 4) was to test the robustness of the IN technique by having independent groups assess the same issue, in some cases with a different facilitator, and comparing the results. There was considerable consistency in the findings and negligible contradiction between the groups. There were some differences in emphasis, largely reflecting the composition of the groups. For example the group involving manufacturers rated the standards of equipment design and provision of information and advice more highly than end-users in other groups. The principal learning was the need to engage a balanced range of participants and seek to check and moderate views wherever appropriate.

Volume 6 explains how the network was customised in certain cases to ensure that issues specific to the topic in question were adequately addressed (e.g. the internal working environment was particularly relevant for plant and in the case of HAVS, design of the work processes as well as the hand tools needed to be distinguished. BOMEL’s facilitation software, MIND, is also described in Volume 6. This provides visual aids to help participants through the IN workshop process and is an electronic repository of all the information generated as illustrated in Figure 20 to Figure 23.
Figure 20  Overview of MIND Influence Network software showing the link to rating details and weightings

Figure 21  MIND - Display of rating definitions and simultaneous recording of narrative, rating and justification
Figure 22  MIND - Display of weightings of underlying factors on factor above, with on-screen positioning (High, Medium Low etc) and automated percentage calculation

Figure 23  MIND - Display of risk controls, paths of influence and extent of rating change
4.7 INDIVIDUAL WORKSHOP AND OVERALL CONSTRUCTION FINDINGS

Each workshop is self-contained and provides detailed insight to the specific issues involved. The Executive Summaries in the appendices to this volume and the supporting reports provide this detail. It is not the purpose of this summary volume to water-down these rich observations and findings and the interested reader is referred to the source material. However, it is appropriate to consider whether, despite the differences, particularly in the immediate factors associated with construction activity, there are consistent paths for influencing improvement revealed by the IN approach.

Sections 5 to 8 provide graphical interpretations of the findings in terms of the potential impact of improving individual factors on reducing risk and key paths of influence for risk control that emerged. Section 9 then develops an aggregated model encompassing the breadth of construction activity considered in the study to give an overall qualitative and quantitative comparison.
5. HAND-ARM VIBRATION SYNDROME IN CONSTRUCTION

A consolidated picture of the key issues emerging as significant (from three parallel IN workshops) for the control of HAVS in construction work is given in Figure 24. A factor may have emerged as being of ‘high’ significance (marked red) because its standards are low and/or because it has a strong weight of influence on other factors through the network detrimental to HAVS. Equally a factor may be indicated as being of ‘low’ significance (marked white), not because the standards are necessarily good but because the weighting in the HAVS context may not be high. The grading implies that, if risk controls can be directed at the more significant factors, then relatively more success in tackling HAVS may be anticipated.

The IN process identifies that the suitability of equipment and standards of maintenance are important direct influences on the propensity for HAVS. However, this needs to be complemented by improved recognition amongst the workforce of the risks, with credible information and advice, leading to compliance with controls. Whilst training and management and supervision combined with effective communication from the organisational level are seen to be important, so too is there a need for a strong health-aware culture to foster change. On the hardware side, the need to engage equipment purchasers and specifiers in the risk reduction cycle was identified, with additional emphasis on designers who have the power to eliminate construction requirements for which use of vibrating equipment is needed. Away from the immediate workplace, it emerged that the over-riding culture from the client and arrangements for safety management and adequate resourcing would influence the ability for change to be effected on site. Underpinning these considerations were the influence of the market and the regulator in highlighting the importance of these health issues.

The workshop and analysis led on to detailed recommendations for risk control measures, the potential impact of which was gauged using the IN. The key areas are listed below and their impact on critical factors identified thorough the network can be seen with reference to Figure 24:

- Target designers – elimination or substitution of the need for vibrating tools
- Target equipment manufacturers – reductions in levels of vibration and increases in efficiency
- Improvements in RELEVANT information and advice
  - Information to be related to intended use of tools
  - Underpins other risk controls
- Information to workers – raise awareness and risk perception of the susceptibility to, and consequences of, HAVS
- Improvements in inspection and maintenance of hand tools to minimise deterioration
- Increase influence of purchasers so that low vibration is a key criterion
- Use of health surveillance to detect early symptoms.
Figure 24  Critical factors considered to influence HAVS in construction
6. CONSTRUCTION TRANSPORT

6.1 INTRODUCTION

Three distinct areas where the accident data showed safety problems associated with construction transport were examined. Findings for each of goods delivery to sites, plant operations and roadworks are presented in turn below. In each case potentially significant factors are graded as described in Section 5 and critical paths of influence for effecting improvement are shown. Section 6.5 consolidates the construction transport findings identifying differences and similarities elucidated through the IN sessions.

6.2 GOODS DELIVERY

Figure 25 highlights the more significant factors where improvement would have a significant influence on the safety of goods delivery. Some of the issues raised through the workshops and data analysis included:

• Unloading is the most hazardous work process - variability of site unloading areas

• Poor communications between contractor and site and in contractual arrangements - responsibilities unclear

• How equipment is used rather than its quality is the issue – safe access to and from cab/trailer may be overlooked

• Driver training needs to include more than just driving skills

• Potentially, small operators, even delivering to larger sites, may only think short term - no complementary safety management or recognition of controls

• Industry would like more prescription and information on risk from HSE

Outputs from the workshop and IN analysis, lead to a number of critical paths (Figure 26) through which to effect risk control. These cover:

• Train to improve competence and risk perception

• Provide basic information to drivers as checklists

• Plan and communicate with delivery point

• Improve inspection and maintenance regimes

• Encourage use of additional equipment, lifting aids and PPE

• Incorporate safety in contractual arrangements for supply / delivery.
SAFETY IN GOODS DELIVERY TO SITE

Figure 25  Factors graded according to strength of influence on goods delivery (weightings – colour-coded, ratings – shown as numbers with construction at poorer end)

SAFETY IN GOODS DELIVERY TO SITE

Figure 26  Critical paths for goods delivery focusing particularly on falls from height
6.3 ROADWORKS

Figure 27 provides corresponding information for critical factors affecting safety at roadworks with associated issues being identified as follows:

- Number of accidents potentially linked to road-building expenditure
- Road users are a significant external hazard for workers at roadworks
- People can become ‘immune’ to the traffic noise around them
- Greater regional consistency is required in requirements for safety equipment
- Managing Agent Contractor schemes appear to be offering advantages in terms of
  - Integration of design and maintenance teams allows lessons to be learnt and fed back into new schemes
  - Long-term maintenance contracts
  - Continuity of workload, investment, stable in-house workforce, knowledge retention & low staff turnover

Critical paths through the network (Figure 28) and emerging risk controls include:

- Improve compliance by increasing supervision
- Link installation and removal of roadworks to traffic levels not times
- Improve risk perception with training/toolbox talks
- Improve risk management, planning and feedback
- Encourage shared stakeholder ownership of problems
- Improve contracting strategies with longer-term relationships and inclusion of H&S as a meaningful selection criterion
- Design for minimum and safe maintenance
- Influence road users to drive safely through roadworks.
SAFETY AT ROADWORKS

**DIRECT LEVEL**

- Competence
- Motivation / Morale
- Task Working
- Risk / Accident Perception
- Health
- Comms
- Information / Advice
- Compliance
- Conditions
- Safety Equipment / PPE

**ORGANISATIONAL LEVEL**

- Recruitment & Selection
- Training
- Procedures
- Planning / Management
- Incident Management / Feedback
- Management / Supervision
- Comms
- Safety Culture
- Equipment Purchasing
- Inspection & Maintenance
- Pay and Conditions
- Design for Safe Construction

**POLICY LEVEL**

- Contracting Strategy
- Ownership & Control
- Company Culture
- Organisational Structure
- Safety Management
- Labour Relations
- Company Profitability

**ENVIRONMENTAL LEVEL**

- Political Influence
- Regulatory Influence
- Market Influence
- Societal Influence

**Figure 27** Factors graded according to potential to influence safety at roadworks

**Figure 28** Critical paths of influence for safety at roadworks
6.4 PLANT OPERATIONS

Figure 29 grades the IN factors based on their significance with respect to safe plant operations judged through the workshop and IN analysis. Issues emerging included:

- Training not always relevant to realities of site
- Standards vary - plant operators on the books of hire companies or contractors are potentially better
- Hazards and risks may be clearer to plant operators than others
- Designers do not understand plant
- Few of the foremen left would have known the job
- Average age of plant operators is 58 – a concern for the future
- Visibility is a key issue
- Have been improvements in plant in recent years
- Hired plant of good quality
- HSE need to work with industry to get solutions

Specific recommendation percolating through the critical paths highlighted in Figure 30 include:

- Improve site practice with
  - Increased supervision
  - Health (eyesight) checks
  - Communicate safety critical information with checklists

- Improve organisational practice
  - Consistent agendas
  - Procurement staff to be aware of H&S implications
  - Education and training of designers

- Regulatory (HSE) issues
  - Clear lead on visibility
  - Working with stakeholders
Figure 29  Factors graded according to potential to influence safety of plant operations

Figure 30  Critical paths identified for construction plant safety
6.5 CONSOLIDATION OF CONSTRUCTION TRANSPORT IN MODELS

From the cross sector assessments described in this section, it is possible to map a set of critical factors onto the Influence Network which it is fair to say are applicable to construction transport safety in general. These are shown in Figure 31 based on a consolidation of the key factors on critical paths highlighted in Figure 25 to Figure 30. Improvement to these factors can be considered as offering the best chance of reducing the risk of construction transport accidents across the industry.

Figure 31 Consolidation of critical factors significant for construction transport related safety

Although the factors in Figure 31 can be considered as common contributors to construction transport accidents, it is still the case that some factors are more relevant in specific areas than others depending on the sector. The critical factors applicable across the construction transport areas are shown in Table 6 against the specific area of transport in which they have been identified as most important. It should also be remembered that other factors have emerged as important in a particular sector.

For example, equipment purchasing, inspection and maintenance and the environment within construction plant as well as site layout and planning of parallel activities are crucial for safety in that area. For roadworks there is a critical role for design and planning to minimise risk exposure of workers. In the case of goods delivery, explicit account of health and safety issues is less evident, despite the frequency of accidents. Contracting strategy in the supply and delivery of material, communications between site and external parties and planning for safe/assisted unloading are vital.
<table>
<thead>
<tr>
<th>Cross Sector Critical Factors</th>
<th>Factors applied to area of transport</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Roadworks</td>
</tr>
<tr>
<td>Competence</td>
<td></td>
</tr>
<tr>
<td>Risk perception</td>
<td>X</td>
</tr>
<tr>
<td>Information/advice</td>
<td>X</td>
</tr>
<tr>
<td>Compliance</td>
<td>X</td>
</tr>
<tr>
<td>Safety equipment</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td></td>
</tr>
<tr>
<td>Management/supervision</td>
<td>X</td>
</tr>
<tr>
<td>Communication</td>
<td>X</td>
</tr>
<tr>
<td>Safety culture</td>
<td>X</td>
</tr>
<tr>
<td>Company culture</td>
<td>X</td>
</tr>
<tr>
<td>Safety management</td>
<td>X</td>
</tr>
<tr>
<td>Regulator</td>
<td>X</td>
</tr>
</tbody>
</table>
7. CONSTRUCTION FALLS FROM HEIGHT

A sequence of networks identifying critical factors and potential paths of influence are paired for consideration of fatal falls from height (Figure 32 and Figure 33 from the Phase 1 pilot), in new-build construction (Figure 34 and Figure 35) and in refurbishment/maintenance type activity on existing structures (Figure 36 and Figure 37). Principal issues emerging included:

- Falls account for around two-thirds of recorded non-fatal accidental injuries
- Significant numbers occur in fit-out and maintenance trades
- Working off of ladders is seen as an everyday activity with little associated risk (or safety training)
- Need to raise awareness of issues - inadequate risk perception - people are aware of hazards but underestimate risks. People recognise risks but no behaviour modification especially at low levels
- Need improved maintenance, training and information for safety equipment and PPE
- Training not necessarily effective measure but formal training could help to raise awareness
- Need more of a reporting culture to learn from incidents
- Designers need information on how to design out risks
- Would like tougher enforcement from Regulator and more prescription
- Inadequate information - managers lack necessary competence
- Difficult to get balance between someone who is skilled tradesman and good at height
- Selection of equipment is problem as opposed to quality
- Contracting strategy could have more influence
Figure 32 Critical factors and significance for fatal falls from height in construction

Figure 33 Critical paths identified for fatal falls from height in the Phase 1 research
Figure 34  Critical factors and significance for falls from height in new build construction

Figure 35  Critical paths identified for falls from height in new build construction
Figure 36  Critical factors and significance for falls from height in construction work on existing structures

Figure 37  Critical paths identified for falls from height in construction work on existing structures
Comparison between the paths in Figure 33, Figure 35 and Figure 37 reveals strong similarities. This demonstrates the potential for consolidating the principal critical paths identified from the three workshops as shown in Figure 39 with the corresponding consolidation of critical factors in Figure 38. Three areas for action to achieve wide-ranging risk reduction emerge as follows:

- **Competence, Risk perception / Situational awareness** and **Compliance** on site (shown in red).

- **Operational equipment** and **Safety equipment / PPE** on site (also shown in red).

- **Design for safe construction** (shown in blue).

The routes of influence for these three categories are shown as being via the **Regulator** influencing **Company culture** and **Health and safety management** in order to influence the extent of **Training** and **Management / supervision** for both of the site categories. For the **Design for safe construction** category, the **Regulator** would need to influence **Contracting strategy** as well as **Company culture** and **Health and safety management** which in turn will lead to improvements in the extent to which safe construction is addressed in design.

Specific measures identified related to:

- Three key themes
  - Design
  - Site practice
  - Low falls

- **Education and training**
  - Education
  - IPD / CPD
  - Suitable information and advice

- **Client influence**
  - Education of clients
  - Include health and safety in contracts

- **Regulatory influence**
  - Audits of designers compliance with CDM duties
  - Involvement in the design process

- **Improving practice**
  - Training leading to competence
  - Provide adequate supervision
  - Selection, use and maintenance of equipment
  - Achieving compliance
  - Modifying company culture
  - Improving safety culture
  - Improving risk perception
Figure 38  Critical factors from consolidated assessment of falls from height in construction

Figure 39  Consolidated critical paths identified for falls from height in construction
8. ASSESSMENT OF HSE INTERVENTION MECHANISMS

In the workshop involving HSE Inspectors, a breadth of construction experience was represented. The most significant influence emerging (Figure 40) led to an assessment of critical paths for action (Figure 41) from which detailed consideration to intervention efficacy was given. Factors addressed by the group included:

• Construction dominated by two cultures:
  • Just get it done
  • It won’t happen to me

• Skills shortage impacts at all levels

• Risk assessments, Method statements and CDM treated as paperwork exercises

• ‘Letter’ of requirements complied with, but not ‘spirit’

• Little information gets to the workforce

• Management & supervision – critical but lacking and influence workforce differently from site to site

• Health and safety needs to be addressed explicitly in contracts to impose a civil liability
Figure 40 Critical factors for construction health and safety identified in the HSE workshop

Figure 41 Critical paths identified in the HSE workshop for construction safety
9. CONSTRUCTION-WIDE THEMES EMERGING

9.1 INTRODUCTION

The foregoing sections have drawn out some of the key observations and findings from the Influence Network (IN) workshops in which different aspects of construction health and safety were considered in detail. The critical factors and critical paths which emerge are based on the rating of the quality of individual factors and the weighting of their interaction judged by workshop participants. This section explores whether there are any common themes which emerge which could be tackled, to underpin the detailed actions in specific circumstances.

This assessment is purely indicative and no rigid quantitative conclusions are being drawn. However, the assumptions are believed to be reasonable and serve to illustrate the potential for future network development.

9.2 RISK INDICES

The ratings and weightings assigned in individual workshops enabled overall risk indices to be calculated reflecting the practices described, as summarised in Table 7. As some of the factors were rated as ranges in the workshops, multiple analyses were undertaken to bound the range of risk.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Risk index – Lowest or representative ratings</th>
<th>Risk index – highest ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall causation workshop</td>
<td>0.33</td>
<td>0.48</td>
</tr>
<tr>
<td>Roadworks</td>
<td>0.41 (General labour)</td>
<td>0.58 (Traffic management)</td>
</tr>
<tr>
<td>Construction Plant</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Construction Goods delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falls – fatal (Phase 1 pilot study)</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Falls – new build construction</td>
<td>0.34</td>
<td>0.65</td>
</tr>
<tr>
<td>Falls – existing structures</td>
<td>0.29</td>
<td>0.51</td>
</tr>
<tr>
<td>HAVS (3 workshops)</td>
<td>0.25-0.32</td>
<td>0.28-0.42</td>
</tr>
</tbody>
</table>

Whilst the index is not treated in this project to have any intrinsic meaning, the fact that the sessions were largely comparable in the factors discussed and scales of practice considered, means some comparison is valid. For example, that some aspects of primary new build construction lead to good safety practices is to be expected based on industry observations and experience. By contrast, the lack of explicit attention to risks associated with goods delivery to construction sites leads inevitably to a lower risk index and substantial potential for improvement.
9.3 BASIS FOR COMPARISON OF RATINGS

Considering the overall challenges for improving health and safety in construction, it is appropriate to focus on the poorer or more representative rating of practices. Table 7 lists these ‘lower’ rating values assigned in each of the ten workshops. It is important to note that some of the Direct level factors concerning the work environment and/or equipment (D11 to D14) were defined differently for the different sessions. Considering plant operations, the in-cab conditions and facilities, the equipment operability and standards of inspection and maintenance were key issues to address. In the case of work at height, safety equipment and PPE required specific consideration. For HAVS it was also necessary to distinguish the design of hand-held tools from the design of work processes requiring their use (O12 & O13). The consolidated table amalgamates some of these factors for illustrative purposes with D12 reflecting all aspects of the work environment, D13 relating to the operability and condition of equipment and D14 similarly applying to safety equipment and PPE.

Table 8 Factor ratings from each workshop, average by topic and overall (colour grading goes from white – poorest quality, to red – better quality)

<table>
<thead>
<tr>
<th>Influence Network factor</th>
<th>HAVS-1</th>
<th>HAVS-2</th>
<th>HAVS-3</th>
<th>FHE</th>
<th>New Build</th>
<th>FHE - Existing</th>
<th>FHE - Phase 1</th>
<th>Roadwork</th>
<th>Plant</th>
<th>Goods</th>
<th>Delivery</th>
<th>IHE</th>
<th>FHE</th>
<th>Trans</th>
<th>Avg.</th>
<th>Avg. recoloured</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Competence</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3.4</td>
<td>3.7</td>
<td>3.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2 Motivation / Morale</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>3.0</td>
<td>3.4</td>
<td>3.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3 Team working</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>5</td>
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<td>3</td>
<td>3.3</td>
<td>3.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4 Risk Perception</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>5.5</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D5 Fatigue</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4.7</td>
<td>4.7</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D6 Health</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>4.8</td>
<td>4.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D7 Communications</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>3.2</td>
<td>3.2</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D8 Information / Advice</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>2.5</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D9 Compliance</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>3</td>
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<td>4</td>
<td>3.8</td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D10 Human Resources</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>3.5</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D11 Internal Work Environment</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>3.4</td>
<td>3.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D12 Env. / Ext. Conditions</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3.5</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D13 Operational Equipment</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>3.8</td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D14 Safety Equipment/PPE</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2.7</td>
<td>2.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

O1 Recruitment and Selection
O2 Training
O3 Procedures
O4 Planning
O5 Incident Man. & Feedback
O6 Management / Supervision
O7 Communications
O8 Health and Safety Culture
O9 Equipment Purchasing
O10 Inspection & Maintenance
O11 Pay and Conditions
O12 Design for safe construction
O13 Equipment design

P1 Contracting Strategy
P2 Ownership and Control
P3 Company culture
P4 Organisational Structure
P5 Safety Management
P6 Labour Relations
P7 Company Profitability

E1 Political Influence
E2 Regulatory Influence
E3 Market Influence
E4 Social Influence
The first three blocks of three columns in Table 8 relate to HAVS and the two major accident categories. These may be considered representative of the health and major injury potential accidents in focus under RHS\(^{(2)}\). In addition, the tenth data column gives a broad view from the breadth of HSE inspector experience. The columns titled HAVS, FFH (fall from height) and Trans(port) represent an average of the three rating scores in each category to avoid undue weighting being given to comparable issues. The final two columns present a further averaging of these topic ratings with the HSE views. A weighted comparison could be made to reflect the different contributions to risk based on accident statistics but the level of refinement is not considered appropriate at this stage. Instead, this assessment is intended to be indicative and representative.

### 9.4 RATING COMPARISONS

The colour shading in the table is intended to help give a visual impression across the rows of consistency and differences in the judgements about standards of performance. The final column re-grades the coding scheme so that the higher and lower rated factors can be distinguished down the column of all network factors.

Some of the apparent anomalies can readily be explained, emphasising the value of the individual workshop foci. For example when considering construction plant, this high value Equipment is generally rated highly (D13) with good standards and explicit attention to Inspection and maintenance (O10) and relatively high rates of Pay for qualified drivers (O12). Indeed the higher ratings are generally associated with the larger scale aspects of construction activity such as falls from height in new build construction, in roadworks and use of plant.

At the poorer end, Contracting strategy (P1) was generally rated poorly across all the workshops in terms of the meaningful treatment of health and/or safety. The exception of roadworks was reflecting the changes in term maintenance arrangements which contractors saw to be enabling greater investment in recruitment and training to sustain a competent and safe workforce.

Whilst the differences are important in developing focused risk controls, the aggregated view also appears to correspond with experience and expectations. With reference to the right hand column of Table 7, Contracting strategy (P1), Design for safe construction (O12), and Feedback and learning from prior incidents (O5) are considered to be particularly poor. Societal influence (E4), Client / project / company culture (P3) and Information and advice (D8) are also considered to have potential for improvement.

The most positive factors overall appear to be the Motivation and morale of workers (D2), their Health (D6) and limited effects of Fatigue (D5); the workshop discussions focused on the self-selection of fit and healthy workers content with the nature of construction work. Amongst the Organisational factors, willingness to purchase Equipment was generally considered to be positive (O9) with Company profitability (P7) being a key factor but reasonably conducive, given the current comparison between equipment and labour costs. Political influence (E1) and that of HSE as Regulator (E2) were also viewed as being relatively positive.
9.5 BASIS FOR COMPARISON OF WEIGHTINGS

Importantly the IN approach considers not only the quality of specific factors but the degree of influence they have the potential to exert on other aspects of performance. Figure 42 through Figure 45 present the averaged weightings from the sets of HAVS, falls, transport and global industry sessions. Again it is important to note that the weighting of direct factors O11 to O14 on accident/ill-health events is not defined consistently between the sessions. Similarly, comparison between the organisational influences on these direct factors is not valid (Figure 43).

9.6 WEIGHTINGS COMPARISON

There is some variability in the weighting assigned to the Direct influences in the topic areas by the different groups. For example, the HAVS groups did not consider the occurrence to depend to any significant extent on the fatiguel/alertness of the workers, whereas in the case of falls and transport accidents this factor had potentially more significance. This is entirely logical and confirms the ability of the IN to distinguish key factors in specific circumstances.

Moving down through the network to the Organisational level (Figure 43), the visual impression of the plotting of individual factors on each direct level factor is of considerable consistency between the workshops. Importantly the shape of the traces in each case varies when comparing the graphs down the table, correctly distinguishing the different influence of the various organisational influences on different direct factors.

Where the influences on D10 (Availability of suitable human resources) have been judged remarkably consistently by the workshop groups, there is greater variability in relation to Health (D6) and Fatigue / alertness (D5) suggesting there is greater uncertainty in terms of how these are affected and/or can be controlled. Looking down the figures it also becomes evident that Training (O2), Management and supervision (O6) and Health and safety culture (O8) are considered repeatedly as having a strong weight of influence on direct performance factors.

At the Policy level (Figure 44), there is again remarkable consistency in the weighting profiles. This tends to confirm that the underlying mechanisms of influence on the industry are relatively consistent irrespective of the specific accident or ill-health scenarios being considered. There are some inconsistencies in relation of O12 (Design for safe construction) suggesting some uncertainty as to the mechanisms for influencing designers. Similarly, looking down the diagrams there is a lack of consistency in the degree to which the workshops thought Contracting strategy (P1) could be used to influence Organisational factors. By contrast, the agreement on the strength of influence of Health and safety management (P5) is considerable.

At the Environmental level (Figure 45) there is reasonable consistency in the overall profile of the sets of influence on individual Policy factors. Those with least agreement are P2 (Ownership and control of health and safety matters throughout a project) and P3 (Company culture) perhaps reflecting genuine uncertainty as to how these client / project / company factors are shaped. This extends to uncertainty in the extent to which HSE, as Regulator (E2), is able to exert influence. By contrast there is, however, clear agreement on the strong influence that HSE can have on Safety management policies and practices.
Direct Influences on Construction health and safety

Figure 42  Variation in the weightings of the Direct level on construction health and safety
Organisational Influence on D1 (Competence)

Organisational Influence on D2 (Motivation / Morale)

Organisational Influence on D3 (Teamworking)

Organisational Influence on D4 (Situational Awareness / Risk Perception)

Organisational Influence on D5 (Fatigue / Alertness)

Organisational Influence on D6 (Health)

Organisational Influence on D7 (Communications)

Organisational Influence on D8 (Information / Advice)

Organisational Influence on D9 (Compliance)

Organisational Influence on D10 (Suitable Human Resources)

Organisational Influence on D11 (Internal Work Environment)

Organisational Influence on D12 (External Working Environment)

Organisational Influence on D13 (Operational Equipment)

Organisational Influence on D14 (Safety Equipment / PPE)

Caution: definitions for D11 varied between workshops and so direct comparison is invalid.

Caution: definitions for D12 varied between workshops and so direct comparison is invalid.

Caution: definitions for D13 varied between workshops and so direct comparison is invalid.

Caution: definitions for D14 varied between workshops and so direct comparison is invalid.

Figure 43  Variation in the weightings of the Organisational level on the Direct level
Policy Influence on O1 (Recruitment & Selection)

Policy Influence on O2 (Training)

Policy Influence on O3 (Procedures)

Policy Influence on O4 (Planning)

Policy Influence on O5 (Incident Management & Feedback)

Policy Influence on O6 (Management / Supervision)

Policy Influence on O7 (Communications)

Policy Influence on O8 (Health and Safety Culture)

Policy Influence on O9 (Equipment Purchasing)

Policy Influence on O10 (Inspection & Maintenance)

Policy Influence on O11 (Pay and Conditions)

Policy Influence on O12 (Design for Safe Construction)


Figure 44  Variation in the weightings of the Policy level on the Organisational level
Environmental Influence on P1 (Contracting Strategy)

Environmental Influence on P2 (Ownership & Control)

Environmental Influence on P3 (Company Culture)

Environmental Influence on P4 (Organisational Structure)

Environmental Influence on P5 (Health & Safety Management)

Environmental Influence on P6 (Labour Relations)

Environmental Influence on P7 (Company Profitability)

E1 – Political, E2 – Regulatory, E3 – Market, E4 – Societal

Figure 45  Variation in the weightings of the Environmental level on the Policy level
9.7 CRITICAL FACTORS AND PATHS OF INFLUENCE BASED ON CONSOLIDATED WEIGHTINGS AND RATINGS

These consolidated findings can be seen to lead to a meaningful interpretation of the influences affecting construction health and safety. The purpose of network analysis is to extend this insight and trace, for example, through the Regulator’s strong influence (E2) on Health and safety management (P5) to see whether P5 is then significant for its weight of influence on those organisational aspects which, in turn, impact on critical direct factors.

An exploratory analysis was performed for the averaged ratings from Table 8 combined with the ‘All’ cases weightings shown with the black lines and solid squares in Figure 42 to Figure 45. This is recognised to be imperfect given the basis for aggregating the views but nevertheless provides an instructive overall assessment. The overall index from the averaging of poor / representative practices is 0.32 which cross-checks with the range given in Table 7. The analyses in which individual factor ratings are increased and overall impact assessed, and critical paths are explored through the network, lead to the findings summarised in Figure 46 which can be seen to reinforce those emerging from the overall HSE workshop discussed in Section 8.

![Diagram of Construction Health and Safety](image)

**Figure 46** Critical paths identified in the HSE workshop for construction safety

Essentially there are two particularly powerful strands of influence emerging: one in relation to site practice (red) and the other through design (blue) exploiting the potential to eliminate hazards and fundamentally affect the risk exposure profile. It is clear that for both developments, the Regulator’s ability to influence Company culture and Health and safety...
management are key and, for design, alternative Contracting strategies and better integration through Organisational structures emerge as significant.

The route from the Policy level to Direct influences on site appears to run most strongly through the provision of appropriate Management and supervision with strong dependence on the pervading Health and safety culture. The combined influence of these, coupled with complementary influences from knock-on effect of Policy changes on Training etc, are seen to impact on the Competence of workers for performing tasks safely based on better Information and advice, improved Recognition of the risks as they might affect them individually, and Communication in the immediate workplace.

9.8 KEY FINDINGS

It is significant that the research has taken an open view of the factors that influence construction health and safety but the conclusions, (based on a wide range of data sources, focus on key risks in the industry, and the views of a wide range of experienced construction practitioners), place attention on those aspects of construction management through the procurement chain that the Construction (Design and Management) Regulations address.

It is also important to reflect that the workshops demonstrate some uncertainty about the ways in which the key Policy influences can be affected, suggesting the potential to develop the IN model further to distinguish the constituent contributions.

Overall however, this consolidation exercise has demonstrated the strength of the IN in modelling construction health and safety practices both in the round and with specific definition of individual aspects of the construction risk profile. The further potential of the network is as a basis for benchmarking key aspects of construction practice and/or as a framework for monitoring the extent of improvements and the knock-on benefits along the critical influence paths.
10. FUTURE DEVELOPMENTS AND APPLICATIONS

The RIDDOR data tool has been shown to be a powerful and efficient way to interrogate notified accident data. Its continued use within HSE will enable strategy development to be evidence-based and will provide a useful reference basis for monitoring progress. The facility to develop bespoke accident sets means that detailed aspects of construction activity can be examined consistently year on year providing new and more detailed insight. As a spin-off from Phase 2, but as part of other HSE research projects, new facilities have been developed to extend the use of the data. These tools for identifying repeating patterns of accident kinds, agents and occupations etc within the dataset and risk ranking in relation not only to the numbers of different accidents but also their cost, will serve to add significantly to the power of the overall toolkit for construction as outlined in Figure 4. Extensive use has been made of text fields within the investigation reports and notifier comments which now accompany the accident data held in FOCUS, and future work could usefully automate these search facilities in a way that makes them more readily accessible to HSE Inspectors and topic specialists.

Specific Influence Network derived recommendations for improving health and/or safety in each of the topic areas examined through the workshops are contained in the individual report volumes and summarised in the appendices to this report and so are not repeated here. Several of these have been carried through to Construction Division’s project plans for coming years and it will be valuable to monitor performance and the factors affected by different initiatives to test whether the IN assumptions were valid and the out-turn is as anticipated. Similarly where research addresses issues which practitioner views suggested were not significant in general for accidents (such as fatigue), it will be important to monitor the research findings and use these to endorse or update the wider understanding embedded in the IN, as appropriate.

Overall, it appears that the IN provides a comprehensive framework for monitoring performance of the industry in aggregate and a model within which current and future practices can be benchmarked. Adopting detailed indicators of performance against the critical factors would give a more sensitive and potentially more accurate mechanism for monitoring and measuring change.

Whilst use of the Influence Network technique has proved successful in this project, it is recognised that further work could be undertaken to develop some of the concepts and issues identified. In particular, work is required to establish how Design for safe construction at the Organisational level could best be integrated into the Influence Network model such that its significance is always reflected appropriately in the analysis. Such an approach may require parallel Influence Network models addressing ‘design’ and ‘site’ issues or a clearer demarcation between construction parties. Work in other industrial applications and specifically through BOMEL’s joint industry project is further refining the IN in this way, expanding its utility and mathematical robustness. Particular areas of development include best practices in eliciting expert judgements – a crucial element for use of the IN or other approaches to supplement limited ‘hard’ data.

The discussion and structured rating and weighting using the IN has revealed potential sources of uncertainty (as opposed to differences of opinion or experience in specific circumstances) concerning the role of Contracting strategy and the way it can be used to exert positive influence
through the supply chain on construction health and safety. Similarly Client / project / company culture and systems of safety management have been shown, repeatedly, to underpin other more detailed improvements that may be contemplated. However, the details of how they can be influenced by the regulator and others needs better definition.

Indeed, the Influence Network technique has been successful in moving the focus from the conduct of work activities to the wider circumstances through which risks are generated and where strategic risk management controls are needed. It is therefore considered appropriate for the Influence Network technique to be used as a basis for developing more detailed insight into the nature and role of Market influences as this was considered to be of fundamental importance by the workshop delegates, but few examples of potential controls or responses were identified. All aspects of economics, finance, insurance and risk would need to be considered in relation to the industry structure(s) and business practices to understand how and why they have influence. This would allow other policy areas that may be influential in risk management such as corporate governance and the tensions between risk transfer and risk retention to be investigated. This understanding could be particularly important to ensure the health and safety developments in the industry are insulated from future market cycles.
11. REFERENCES


APPENDIX A

INTRODUCTION TO THE INFLUENCE NETWORK
A. INTRODUCTION TO INFLUENCE NETWORKS

A.1 BACKGROUND

Influence diagrams are used to identify principal factors which influence each other and the outcome of a set of circumstances. These have been used as qualitative socio-political modelling tools for many years. In the 1980s a particular form of influence diagram, now termed an ‘Influence Network’ to distinguish its form from the many influence diagram types in existence, was developed to model how human and organisational factors could affect the likelihood of human error leading to accidents in hazardous environments (e.g. nuclear power stations, petrochemical plants, aerospace).

In 1995, following a House of Lords review of marine safety, the UK Marine Safety Agency (now the Maritime and Coastguard Agency, MCA) commissioned BOMEL to lead the development of a comprehensive risk based methodology for potential use by the International Maritime Organisation (IMO) as a basis for future improvement of shipping safety. The resulting methodology was adopted by the IMO and is now incorporated into IMO Guidelines for this purpose. One element of BOMEL's work was to carry out a full review of methods to account for human performance within the context of the technical, organisational and wider commercial and social spheres as illustrated in Figure 1.
The Influence Network approach for human performance was enhanced by BOMEL to cover human and hardware performance in a single analysis thereby giving a comprehensive approach to understanding the factors which influence the likelihood of human error or hardware failure in the causation of accidents. This approach has rapidly gained wide acknowledgement and has been applied in risk assessment and, perhaps more importantly, in the development of risk reduction strategies for a variety of accident scenarios in a wide range of industrial sectors. The structuring within the network gives coherence to fragmented information and the quantification enables weaknesses and areas where change may achieve substantial benefit to be identified.

A.2 METHODOLOGY

The Influence Network is developed from consideration of a generic set of influences which are structured in a hierarchy representing the influence domains shown in Figure 1. The Generic Influence Network is shown in Figure 2 and described in the following sections. Table 2, at the end of this Appendix A, defines each factor.
Below the top event is the direct causal level which is made up of human, hardware and external factors. Generally, there will be data available from which the direct causes can be determined and the relative importance quantified. Where the data are often unhelpful is in understanding and delineating the underlying influences which nevertheless have a great bearing on the likelihood of an incident occurring and on the outcome or consequences. In addition, these considerations can determine the appropriate risk controls to prevent a future occurrence. For example, an inappropriate action by an individual leading to an accident may be due to a lack of competence which then might be attributable to no training having been given, the training being deficient, the need for refresher training, inappropriate recruitment or verification of competence etc, with different parties and approaches needing to be encouraged to correct the situation and make long-term changes to prevent recurrence.

In order to model these influences, the Influence Network has adopted a hierarchy below the direct causal level as follows:

- **Direct performance influences** - these directly influence the likelihood of an accident being caused.

- **Organisational influences** - these influence direct influences and reflect the culture, procedures and behaviour promulgated by the organisation.

- **Policy level influences** – these reflect the expectations of the decision makers in the employers of those at risk and the organisations they interface with (e.g. clients, suppliers, subcontractors).

- **Environmental level influences** - these cover the wider political, regulatory, market and social influences which impact the policy influences.

In terms of the construction industry, the relevant stakeholders were felt to fit into the model as shown in Table 1.

<table>
<thead>
<tr>
<th>Influence level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct level</td>
<td>Applies to site operatives and technicians, i.e. the people actually carrying out the construction work, the equipment they use and the site conditions.</td>
</tr>
<tr>
<td>Organisational Level</td>
<td>Applies to the site organisation and local management and those, such as designers, who influence the work to be undertaken.</td>
</tr>
<tr>
<td>Policy Level</td>
<td>Applies to both the client and construction company management. Contracting strategy, ownership and control and company culture apply first to the client (i.e. the organisation commissioning and paying for the construction activity) and then cascade through the parties in the supply chain, with the remaining policy factors applying particularly to the contractors carrying out the work.</td>
</tr>
<tr>
<td>Environmental Level</td>
<td>The Political Influence incorporates both national and local government procurement strategy as well as government as guardians of worker and public safety. Otherwise the Environmental Level influences are external to the organisations represented at the Policy Level and include HSE as health and safety regulator, insurers and others affecting the market and the general public with the potential to exert societal influence.</td>
</tr>
</tbody>
</table>
At each level of influence, influencing factors have been identified as shown in the network in Figure 2. The factors have been distinguished based on accepted theories of human factors and safety and risk management, and the categories have been expanded further and refined through practical application to a range of scenarios. Each influence in the generic network is defined together with an anchored rating scale from worst to best practice (0 to 10). This provides a basis for making judgements about the relative importance of each influence (weighting), the current quality of each influence (rating) and the potential effect on the quality of the influence by introducing risk control measures.

The process of customising the Influence Network for application to a specific problem comprises a sequence of steps which are detailed in Volume 6 of this report series (see Appendix F). In summary the steps cover:

- An introductory review of available data or other information putting the top event / safety or health scenario in context.

- Identification and customisation, where necessary, of the influencing factors in the particular area of concern and structuring of the Influence Network such that these factors can be investigated.

- Discussion and rating of these factors in terms of current practice. This forms a very important and stimulating part of the workshop for participants, with the network and structured approach providing a catalyst for detailed discussion and offering new ways of thinking about issues underlying health or safety concerns.

- Examination of the inter-relation between and weighting of the influence of each of the factors on other factors. This provides important insight to the mechanisms of influence affecting current practice.

- Identification of possible risk control measures and their potential efficacy.

Prior to the workshops each of the participants is provided with a briefing document explaining the Influence Network approach and setting out the issues and areas of influence to be examined. BOMEL’s software tool, MIND, structures and facilitates the workshop process and links to a database in which key aspects of the discussion and justifications for the assignment of weightings and ratings are stored. This provides a full audit trail and a rich information source against which future monitoring of performance can be compared. The assimilation of the qualitative insight is also extremely important for interpreting any quantitative evaluations.

The risk assessment and influence quantification process can generally be achieved in a one-day workshop. The ideal number of participants is around four to eight experts plus facilitator and recorders. However, a two-day workshop is preferable in order that development of risk controls can be undertaken interactively with the workshop participants, giving more opportunity to consider the alternatives, as well as appropriate resource commitments, timing and degree, and indicators of improvement.
It is important to note that where workshops address different top event scenarios with customised factors or rating scales, there is no basis for detailed quantitative comparisons. The aim is to enable the relative impact of alternative controls to be compared in terms of risk reduction for each given scenario. This is considered to be the more powerful and useful application than retaining a consistent but ill-fitting set of factors across a range of scenarios.

A.3 ANALYSIS OF THE INFLUENCE NETWORK

Having consolidated information within the network, analyses can be performed to assess the levels of risk, to identify critical factors and paths of influence where change has the potential to significantly reduce risk, and to assess the impact of proposed risk controls. This section describes the methodology for analysing the IN and Section A.4 describes its use in assessing risk controls.

It is important to stress that the purpose of quantification and analysis is to enable qualitative input from the workshop participants to be weighed up logically and systematically. Where hard evidence and reliable quantitative data exist, then such sources should be used to inform decision making. However, where none exists or when independent validation / triangulation is required, then a semi-quantitative approach utilising judgements can provide an important source of information. Such quantification should not, however, be taken as absolute but should be used intelligently as an ‘indicator’. In this way the combined consideration of qualitative information and quantitative indicators from the Influence Network can be an invaluable tool to aid decision making (see main report Figure 3).

The process of Influence Network quantification based on the ratings and weightings provided by the workshop participants considers the total strength and effectiveness of influences from a lower level to be determined as the sum of the product of the ratings and weightings. This calculated ‘rating’ of the higher level influence can then be compared and resolved with the direct assessment of the influence determined at the workshop. The process is carried out through the entire network to give an overall ‘index’ which can be broadly related to risk. A spreadsheet program is used to carry out these and other calculations.

Some of the factors may be rated as ranges in the workshops reflecting different groups (e.g. major contractors or ‘white van man’) or areas of activity (e.g. term maintenance as opposed to traffic management elements of road works). Where there is little difference between the lowest and highest ratings, this range can be an indication that there is an element of uncertainty in the opinions of the workshop delegates. However, when there is a large range, the highest ratings actually serve to provide an indication of where better practices are currently being achieved and thus highlight the potential for others to achieve those ratings. In order to provide an indication of the resulting range of risk indices, a number of analyses can be undertaken for each workshop reflecting different scenarios. These can be bounded using the lowest rating for each of the factors where a range was given and, alternatively, the highest rating for each of these factors.

It should be noted that the overall risk index alone has little intrinsic meaning. However, were all the ratings of influencing factors to be at 10 (i.e. representing best conceivable practice), the risk index would be 1.0. Were performance at its very worst, the index would be 0.0. In this
context a relationship with risk can be determined by postulating, for example, that the difference between overall best and worst possible practice is equivalent to, say, three orders of magnitude of risk. (Individual risks span $10^3$ from the border of tolerability to the level where society currently places no demand for further risk reduction however low the cost and this therefore can be argued to provide a reasonable reference basis).

The analysis methodology described above is not intended to provide precise projections. However, it does provide a reasonable framework for estimating the potential for relative risk reduction offered by various risk control options and particularly differentiating options with significant potential from those which may have limited impact.

### A.4 OBTAINING RISK CONTROLS FROM THE INFLUENCE NETWORK

In addressing the need for performance improvement in the industry (risk controls), a number of approaches have been taken, and are recommended, in order to identify potential measures, including:

- Seeking suggestions from workshop delegates as to what is current good practice both in construction and by looking at other industries / hazards and controls, and what improvements could be made in the future.

- Interrogating the Influence Network to identify the critical factors influencing health and safety in construction.

- Holding risk control workshops to explore areas for action and specific measures in more detail.

- Identifying best practice and risk controls from the literature and industry contacts.

The potential effectiveness of each of the risk controls identified can then be evaluated as described in Section A.3 and the relative impact of alternative measures can be compared.

Having used the network analysis to identify key factors and critical paths, a set of specific improvements (risk controls) can be postulated prompted by suggestions emerging directly or indirectly from the workshop and analysis. The extent of change in each factor can be varied more precisely based on the control measure envisaged and the combination of factors affected. This gives an indication of the potential impact of each risk control measure, enabling the relative effectiveness of alternative strategies to be compared.

Any one or a combination of risk control modelling or IN analysis techniques can be applied to identify (and triangulate) key paths of influence to exploit with risk controls. It is then important also to run sensitivity analyses, where appropriate, to reflect the uncertainty in ratings assigned by the workshop groups and thus ensure that recommendations are based on patterns of influence whose strength is robust even in the face of uncertainty or variability in the standards of current performance.
As measures are implemented and performance data obtained the model can be refined and updated in light of the improved knowledge.

A key benefit of the IN, is that it provides a structured and systematic framework for assessing a range of potential risk controls affecting different parties through the construction supply chain, whether related to human, hardware or other external factors.

A fuller description of the IN and its specific application in the construction industry context is presented in Volume 6 of this report series – see Appendix F of this report for further details: Generic model for health and safety in construction.
<table>
<thead>
<tr>
<th><strong>DIRECT LEVEL FACTORS DEFINITIONS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 – Competence</td>
<td>The skills, knowledge and abilities required to perform particular tasks safely.</td>
</tr>
<tr>
<td>D2 – Motivation / Morale</td>
<td>Workers incentive to work towards business, personal and common goals.</td>
</tr>
<tr>
<td>D3 – Teamworking</td>
<td>The extent to which individuals work in teams and look out for each other's interests.</td>
</tr>
<tr>
<td>D4 Situational Awareness / Risk Perception</td>
<td>The extent to which workers are aware of hazards and risks.</td>
</tr>
<tr>
<td>D5 - Fatigue/Alertness</td>
<td>The degree to which performance is degraded, for example, through sleep deprivation, or excessive / insufficient mental or physical activity, or drugs / alcohol.</td>
</tr>
<tr>
<td>D6 – Health</td>
<td>The well being of body and mind of the workforce.</td>
</tr>
<tr>
<td>D7 – Communications</td>
<td>The extent to which the frequency and clarity of communications are appropriate for ensuring effective task and teamwork.</td>
</tr>
<tr>
<td>D8 - Information / Advice</td>
<td>The extent to which people can access information that is accurate, timely, relevant and usable.</td>
</tr>
<tr>
<td>D9 – Compliance</td>
<td>The extent to which people comply with rules, procedures or Regulations.</td>
</tr>
<tr>
<td>D10 - Suitable Human Resources</td>
<td>The relationship of supply to need for suitable human resources. Relates to the appropriate mix and number of workers in terms of experience, knowledge and qualifications.</td>
</tr>
<tr>
<td>D11 - Internal Work Environment</td>
<td>The level of noise, temperature, congestion, light and vibration existing in the place of work.</td>
</tr>
<tr>
<td>D12 - External Working Environment</td>
<td>The conditions external to the site which impact on construction activity e.g. weather, public proximity, external distractions etc.</td>
</tr>
<tr>
<td>D13 - Operational Equipment</td>
<td>The extent to which OPERATIONAL equipment and materials are available, conform to best practice, meet the usability needs of the operator and are inspected and maintained.</td>
</tr>
<tr>
<td>D14 - Safety Equipment / PPE</td>
<td>The extent to which SAFETY equipment / PPE is available, conforms to best practice, meets the usability needs of the worker and is inspected and maintained.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ORGANISATIONAL LEVEL FACTOR DEFINITIONS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>O1 - Recruitment and Selection</td>
<td>The system that facilitates the employment of people that are suited to the job demands.</td>
</tr>
<tr>
<td>O2 – Training</td>
<td>The system that ensures the skills of the workforce are matched to their job demands.</td>
</tr>
<tr>
<td>O3 – Procedures</td>
<td>The system that ensures that the method of conducting tasks and/or operations is explicit and practical.</td>
</tr>
<tr>
<td>O4 – Planning</td>
<td>The system that designs and structures work activities</td>
</tr>
<tr>
<td>O5 - Incident Management + Feedback</td>
<td>The system of incident management that ensures high quality information is available for decision-making when and where it is required, including the collection, analysis and feedback of incident and near-miss data.</td>
</tr>
<tr>
<td>O6 - Management / Supervision</td>
<td>The system that ensures human and hardware resources are adequately managed/supervised.</td>
</tr>
<tr>
<td>O7 – Communications</td>
<td>The system that ensures that appropriate information is communicated clearly to its intended recipients.</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>O8 – Health and Safety Culture</td>
<td>Product of individual and group values, attitudes, competencies and patterns of behaviour in relation to health and safety.</td>
</tr>
<tr>
<td>O9 – Equipment Purchasing</td>
<td>The system that ensures that the appropriate range of equipment is available.</td>
</tr>
<tr>
<td>O10 - Inspection + Maintenance</td>
<td>The system that ensures equipment and materials are maintained in good working order.</td>
</tr>
<tr>
<td>O11 - Pay + Conditions</td>
<td>The remuneration package and benefits in the context of working hours and conditions and welfare facilities. Also welfare facilities.</td>
</tr>
<tr>
<td>O12 - Design for Safe Construction</td>
<td>The process of design to ensure buildability of new structures, and operability and safety during maintenance, repair, and refurbishment of existing structures (both in relation to the existing structure and the design of any repair, maintenance or refurbishment scheme).</td>
</tr>
</tbody>
</table>

**POLICY LEVEL FACTOR DEFINITIONS**

<table>
<thead>
<tr>
<th>P1 - Contracting Strategy</th>
<th>The extent to which health and safety is considered in contractual arrangements and the implications.</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2 - Ownership and Control</td>
<td>The extent to which ownership and control is taken over sustained health and safety performance.</td>
</tr>
<tr>
<td>P3 - Company Culture</td>
<td>Culture within an organisation consists of assumptions about the way work should be performed; what is and what is not acceptable; what behaviour and actions should be encouraged and discouraged and which risks should be given most resources.</td>
</tr>
<tr>
<td>P4 - Organisational Structure</td>
<td>The extent to which there is definition of health and safety responsibility within and between organisations</td>
</tr>
<tr>
<td>P5 - Health and Safety Management</td>
<td>The management system which encompasses health and safety policies, the definition of roles and responsibilities for health and safety, the implementation of measures to promote health and safety and the evaluation of health and safety performance.</td>
</tr>
<tr>
<td>P6 - Labour Relations</td>
<td>The extent to which there is a harmonious relationship between managers/directors and the workforce. It also concerns the extent to which there is the opportunity for workers to affiliate with associations active in defending and promoting their welfare, and the extent to which there is a system in place for pay negotiation.</td>
</tr>
<tr>
<td>P7 - Company Profitability</td>
<td>The extent to which companies are subject to competition over market share and constrained as to the price that they can charge.</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL LEVEL FACTOR DEFINITIONS**

<table>
<thead>
<tr>
<th>E1 - Political Influence</th>
<th>The profile of, and practices within, Government related to safety in the industry.</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2 - Regulatory Influence</td>
<td>The framework of Regulations and guidance governing the industry and the profile and actions of the Regulator.</td>
</tr>
<tr>
<td>E3 - Market Influence</td>
<td>The commercial and economic context affecting the industry.</td>
</tr>
<tr>
<td>E4 - Societal Influence</td>
<td>Aspects of the community and society at large, which bear upon organisations and workers.</td>
</tr>
</tbody>
</table>
APPENDIX B

RIDDOR DATA ACCIDENT ANALYSIS TOOL

REPORT VOLUME 2

EXECUTIVE SUMMARY
B. RIDDOR ACCIDENT DATA ANALYSIS TOOL – VOL 2 –
EXECUTIVE SUMMARY

“This report has been prepared by BOMEL Limited for the Construction Division of the Health and Safety Executive and describes the development and use of the RIDDOR Data Tool.

The work described in this report comprises Volume 2 of Phase 2 of the project ‘Improving Health and Safety in Construction’, the other parts of which have also been carried out by BOMEL. This project follows on from the successful completion of Phase 1 which comprised a pilot study trialing a combination of data analysis and an Influence Network technique to understand the organisational and human factors influencing the health and safety of workers in the construction industry. The three key objectives of the study reported in this volume are to:

1. Produce a data handling tool for use both by the HSE and by BOMEL in the later activities in this project.
2. To provide a means of obtaining an up-to-date and thorough report of the accident profile across all construction activity.
3. To provide a user-friendly flexible system for interrogating, analysing and reporting accident data.

The RIDDOR Data Tool has been developed to meet these objectives. The Tool comprises a Microsoft Excel Pivot Table and Chart containing the RIDDOR accident data reported to HSE between 1996/97 and 2001/02 as coded within FOCUS. The adoption of this format provides HSE with an interactive standalone package that operates on standard Microsoft Office software.

The RIDDOR Data Tool is underpinned by an accident database created in Microsoft Access from the raw data supplied by HSE. A bespoke import tool has been developed to take the raw data and incorporate it into the database in a standard format. Once in the database, validation procedures are followed to ensure that the data is compatible with that published by HSE. Records are kept within the RIDDOR Data Tool itself such that the validation process is transparent to all potential users. Each year when the accident is issued by HSE, the new year’s data can be added to the database and the RIDDOR Data Tool updated via an automatic link. This will result in up-to-date data being available for analysis in the RIDDOR Data Tool soon after it has been released and in a consistent format that the user is familiar with from previous analyses. In this way year-on-year trends can be identified readily. Only relatively minor changes were required to incorporate the change to the Incident Contact Centre (ICC) accident recording system in 2001/02, but care is required in making year-on-year comparisons after 2001/02 because of changes to the FOCUS coding scheme.

Within the RIDDOR Data Tool, analyses of the accident data can be undertaken graphically using the Pivot Charts, enabling the user to drill down into the depths of the data in any number of combinations answering ‘what if?’ questions in a matter of seconds. As such, analyses can be undertaken using any of the fields reported under the RIDDOR system. Typically, the most informative fields are those involving the accident kinds, occupations, work processes and
agents involved in the accidents. A standard set of the most useful fields is included in the Tool. Within this report, both background information and detailed instructions are provided in order to provide HSE users with valuable insight into the accident data.”
APPENDIX C

CONSTRUCTION TRANSPORT ACCIDENTS
UNDERLYING CAUSES AND RISK CONTROL
REPORT VOLUME 3
EXECUTIVE SUMMARY
“INTRODUCTION AND OBJECTIVES

This report has been prepared by BOMEL Limited for the Construction Division of the Health and Safety Executive and describes a study on the underlying influences on and control of accidents in construction transport.

The work described in this report comprises part of Phase 2 of the project ‘Improving Health and Safety in Construction’ the other parts of which have also been carried out by BOMEL. This project follows on from the successful completion of Phase 1 which comprised a pilot study trialing an Influence Network technique to understand the organisational and human factors influencing the health and safety of workers in the construction industry. The approach not only provided new insight to the interrelation of the influences between the parties involved, but it also offered a mechanism for identifying areas where improvements will be effective in reducing risk, and for evaluating their potential effectiveness.

The four key objectives of the study are to:

1. Establish an estimate of the likely scale of the workplace transport accident problem in construction from the information and data available such that it can be used to inform subsequent parts of the study and ultimately give a baseline against which to monitor any intervention measures.

2. Identify the underlying influences and causes related to workplace transport accidents in the construction industry by holding Influence Network workshops with key stakeholders.

3. Evaluate the potential effectiveness of a variety of risk prevention and control measures in these workshops.

4. Generate a set of practical and cost effective risk control options in relation to workplace transport accidents that are applicable to the construction industry.

SCALE OF THE WORKPLACE TRANSPORT PROBLEM IN CONSTRUCTION

In October 2000, the HSC agreed to establish eight ‘Priority Programmes’ within its Strategic Plan. Two of these priority programmes are Construction and Workplace transport. This decision acknowledged that a major reduction in construction and workplace transport accidents would go a long way towards achieving the Revitalising targets. The HSC discussion document Preventing workplace transport accidents indicates that as the construction sector has its own priority programme, workplace transport problems specific to construction will be dealt with in the Construction Priority Programme. However, there are likely to be many common issues relevant to both the Construction and Workplace Transport Priority Programmes.
Over the last five years around 33% of UK industry fatalities occurred in the construction industry of which 36% could be broadly classed as construction workplace transport accidents. Put another way, around 12% of the fatal injury accidents in UK industry are due to construction workplace transport. The corresponding figures for major injury accidents are 16%, 29% and 4% respectively. Thus, a 40% reduction in the number of construction workplace transport accidents would lead to a reduction of around 5% in the overall number of fatal injury accidents and around 2% in major injury accidents.

In considering a definition of workplace transport in construction, the following three specific categories have been identified and are subsequently used to define construction workplace transport:

- **Highways** – this is primarily aimed at work on and around live highways and includes such activities as road maintenance.

- **Plant** – this is aimed at the majority of construction activity where plant such as dumpers, scrapers, dozers etc are used.

- **Goods** – this is aimed at delivery to and from construction sites, and is likely to have many similarities with goods-related issues identified in the manufacturing and services sectors.

The RIDDOR reported accident data have been analysed for the period 1996/97 to 2001/02. Within the bands of the under-reporting of accidents, a baseline of accidents resulting from workplace transport activities in construction can be derived from this data. However, this data set has to be built up by identifying individual accident kinds, occupations, work processes and agents that are likely to be involved in construction transport activities. The new ICC accident data system will make some of the key data fields easier to interpret. In particular, it has been found that the changes to the ‘Work process’ and ‘Agent’ fields offer extra categories that are more meaningful than the previous FOCUS system. However, the change to the ICC system does introduce a discontinuity in the accident data from 2001/02 onwards. This means that it is not possible to follow the year-on-year trends for particularly useful fields such as ‘Work process’ and ‘Agent’ from the 1996-2001 data into the 2001/02 set.

For **roadworks**, the data indicated that the number of accidents appears to be related to the expenditure on roads. Struck by accidents appear to present the greatest hazard with private as well as work vehicles heavily implicated.

For **goods delivery**, the data indicated that ‘struck by’ accidents involving goods drivers especially while loading/unloading account for most major injury accidents. Handling injuries are responsible for most over 3 day injury accidents. Trips and falls from height on or around vehicles are significant accident kinds. The largest number of accidents involved goods drivers. The loading/unloading work process should be split into two, as experience indicates that the unloading activity is considered to be more variable, and contributes a larger number of accidents.

For **construction plant**, the data showed that being struck by a moving object, vehicle or machinery, low-level falls, and electrical accident kinds appear most often.
construction workers (i.e. those working around plant) are involved in more accidents than plant drivers. The main work activities involved in these accidents are on site transfer, loading/unloading and general ground works. The primary vehicles involved in plant accidents are forklift trucks, excavators, lorries, dumpers and dump trucks.

HSE Specialist Inspector Reports suggest that the two main risk areas in construction plant accidents are striking pedestrians and the accidental operation of controls, especially gears. An HSE FOD survey on construction transport accidents indicates that vehicle overturn accidents are related to poor ground conditions and the gradient of traffic routes. The underlying factors appear to be inappropriate selection and use of vehicles leading to stability problems. The main issue in ‘struck by’ accidents is the separation of vehicles and pedestrians. All round visibility problems seem to be an underlying factor caused by shortcomings in design.

Given that the UK construction workload is split between new build work and work on existing structures with each sector having different risk profiles, mechanisms are required in the accident data recording to separate out new build work from that carried out on existing highways and structures.

UNDERLYING CAUSES AND INFLUENCES

Three Influence Network workshops have been held successfully with a wide range of delegates representing the key stakeholders. These workshops generated significant input and discussion, which has been analysed to gain an insight into the underlying influences on construction workplace transport accidents and potential risk control measures. The Influence Network technique provides a means of collating the views of a range of stakeholders to identify the causation of construction workplace transport accidents. It also provides a means of identifying critical factors to be addressed as potential risk controls.

Study of the underlying causes of accidents at roadworks indicated that:

- There are essentially two parallel sources of risk: from the construction activities, and from the road users.

- There are a series of industry profiles, with the term maintenance and traffic management contractors who specialise in roadworks at one end, and the repair and labour only contractors at the other end.

- Of the factors that have a Direct influence on safety at roadworks, Competence and Compliance have been identified as being amongst the most significant factors. These are followed by Teamwork, Risk perception, Fatigue/alertness and Safety equipment/PPE.

- Of the Organisational level factors influencing safety at roadworks, Training, Management and supervision, Safety culture and Design for safe construction stand out as the most significant factors, followed by Procedures, Planning and Communications.
• Of the Policy level factors, Company culture and Safety management are the primary influences followed by Ownership and control.

• Of the Environmental level factors, the Political, Regulatory and Market influences are far more significant than the Social influences.

• On a positive note, there was a feeling that the roadworks situation had improved significantly over the last year or so (2001-2) with the introduction of long-term contracts that provided continuity of work and enabling investments to be made.

Study of the underlying causes of accidents involving construction plant indicated that:

• Of the factors that have a Direct influence on accidents involving construction plant, Competence Communications, Information/advice and Safety equipment have been identified as being the most significant factors.

• Of the Organisational level factors influencing on accidents involving construction plant, Management and supervision, Communications and Safety culture stand out as the most significant, followed by Training, Planning and Incident management and feedback.

• Of the Policy level factors, Ownership and control, Company culture and Safety management are the primary influences.

• Of the Environmental level factors, the Regulatory and Market influences are far more significant than the Political or Social influences.

Study of the underlying causes of accidents involving goods delivery indicated that:

• At the Direct level, Competence, Situational awareness / risk perception, Communications, Information / advice, Conditions and Equipment operability were judged to have a significant influence.

• At the Organisational level, Training and Safety culture are the most significant followed by Procedures, Planning, Management / supervision and Organisational communication.

• The Policy level factors with the greatest significance are Contracting strategy, Company culture and Safety management.

• At the Environmental level it is the Regulatory and Market influences that are thought to be strongest.

A number of common themes were identified for construction work transport accidents in general, these are as follows:
There are similarities across the sectors in that the level of training is directly related to how specialised the job is. It is those in less specialised groups e.g. general labour on roadworks, flatbed lorry drivers, small dumper truck drivers who have less competence in terms of safety.

Risk perception is affected by complacency whereby the prevailing attitude is that the individual will not have an accident because they feel that they know what they are doing.

There are common shortcomings with information on transport safety. Often the information does not exist for certain hazards and risks associated with routine work, or the information which is available is not accessible or user friendly to those who need it.

In terms of compliance, it is apparent that in all sectors workers are liable to take short cuts in order to get the work done more quickly and easily, either through human nature or management pressure.

Equipment/PPE issues varied across the sectors. Example problems include equipment used wrongly in goods delivery, not fitted as standard in plant and not being maintained properly in roadworks. However, all of these problems seem to relate to the human factors around the provision, use and upkeep of equipment as opposed to the quality of equipment which is available.

A common theme across sectors related to the role of supervisors. In goods delivery and plant the level of supervision was felt to have reduced, and this was thought to be detrimental in terms of safety. In roadworks there has been recognition of the importance of supervisors and, as such, the amount of supervision has been increased in the past year, and this was felt to be a positive move.

In all sectors there was thought to be a wide range of standards in terms of safety culture. The general feeling was that safety culture tends to be better in the larger or more dedicated operations, but there is room for improvement across the board.

Company culture and safety management were judged to have most influence on the significant organisational influences on construction transport safety. It is necessary to stress the cost benefits of a good safety culture in order to encourage buy in from companies. Larger companies are developing safety management systems across the sectors, but this has not yet filtered down to smaller organisations.

There is agreement that the market has the strongest influence on company culture, whilst the Regulator has the strongest influence on safety management.
RISK PREVENTION AND CONTROL MEASURES

A number of approaches have been taken in order to identify a series of potential risk control measures including:

- Seeking suggestions from workshop delegates as to what is current good practice both in construction and by looking at other industries / hazards and controls, and what improvements could be made in the future.

- Interrogating the Influence Network to identify the critical factors influencing workplace transport accidents in construction.

- Identifying specific examples of good practice already in use in the construction industry both from experience and the literature.

Over a hundred individual risk control measures were generated from these approaches.

In order to reduce the overall risk of construction transport accidents, the following generic areas of risk control were identified:

- Train those in less specialised groups.

- Increase risk perception of each particular sector.

- Provide information that focuses on the primary hazards and risks in a usable format for those who need it.

- Provide the appropriate level of supervision to ensure workers do not take unsafe shortcuts.

- Encourage the appropriate selection and use of equipment.

- Improve safety culture and safety management across the board but especially in smaller organisations.

It is recommended that the following areas should be addressed in order to improve safety at roadworks:

- **Improve compliance** by providing the appropriate level of supervision such that workers are not left to their own devices. This would also be expected to lead to increases in quality and productivity. By linking the installation and removal of roadworks to traffic flows rather than fixed times of the day, would allow earlier access in times of low traffic flows, but also require earlier removal ahead of times of high traffic flows. This should encourage greater compliance as the rules would not be viewed as being arbitrarily based on times. Contingency plans need to be provided
for when traffic levels do not drop off as expected in order to avoid roadworks in dangerously high traffic flows.

- **Increase situational awareness/risk perception** by providing refresher training and regular toolbox talks to remind workers of the risks and remind them of their own fatigue limits. Only specialist contractors with experience of roadworks should be included on tender lists to ensure that those people who work on roadworks have the right appreciation of the risks in the first place.

- **Improve the provision of consistent information/advice** by making safety information more accessible and usable, and make people aware of its existence (checklists and aide-memoirs are a useful way of presenting a summary of the salient information). Also make working files (which contains risk assessments etc.) available to everyone on a job who needs it to ensure that even those in small teams have the information they need to do a job safely. HSE inspectors should look to raise awareness and compliance in a consistent fashion. Regional highway authorities should adopt consistent safety requirements in their contracts.

- **Improve risk management, planning and feedback** whereby managers should ensure there is a 3-stage system of checking method statements in place involving the office, the supervisor and those doing the work. The site foreman should make a decision at the point of work as to whether a method statement is adequate for the work or not. Weather forecasts should be checked when planning road works in order to avoid workers being exposed to poor working conditions and the effects of limited visibility (on both workers and drivers). Managers and supervisors should promote the feedback of incidents that happen on site, and disseminate this information.

- **Encourage more collective ownership of safety and improvements in safety culture** by encouraging the industry stakeholders to work together in addressing safety problems as they have done in the development of the Guidance for safer temporary traffic management. Safety management systems should not only be developed, but also actually used. Regular safety meetings should be held and senior managers should be invited to attend these.

- **Improve client contracting strategy** as the clients for roadworks have the opportunity to make a significant contribution to improving safety through this route. Given that the majority of roadwork clients are in the public sector, there is the potential for Political influence to be brought to bear on such work, and bring the regional highways authorities up to a similar level as the Highways Agency. Potential measures to reduce the risk via contracting strategy include making safety considerations explicit in contracts. Specialist contractors should be included on the tender lists to ensure that those people who work on roadworks have the right experience appreciation of the risks in the first place. Clients should also consider long-term maintenance contracts such that companies can plan and invest for the long-
term, thus enabling skills development and retention, continuity and the opportunity to develop as a team.

- **Encourage design for minimum and safe maintenance.** Whilst the preferable option is to avoid maintenance if possible, there will be situations where maintenance is unavoidable. In those situations, the designer should consider how maintenance will be carried out, and produce designs to make such maintenance as easy and safe as practicable.

- **Influence road users to drive more carefully in road works.** The driving test could be used to improve driver competence in roadworks. Roadworks should be standardised around the country to improve driver awareness of the hazards. Campaigns should be targeted at motorists to raise their awareness of how fatigue and breaking the speed limit increase the chance of accidents, particularly in roadworks. These should be hard hitting along the lines of drink driving campaigns.

Given the proposed increase in expenditure on roads over the next ten years, the relationship between expenditure on roads and highways accidents should be investigated to identify in detail where previous accidents have occurred in relation to the expenditure. This can then be compared to the proposed work and the organisation likely to be involved in that work in order to identify what mitigating measures can be undertaken.

It is recommended that the following areas should be addressed in order to improve safety in and around construction plant:

- **Improve the training measures and raise awareness** by including practical elements in training courses, with the use of on-site training and to integrate the training schemes better. Focus training on plant performance, in particular in hazardous conditions highlighting the limits of machine and human performance. Encourage the industry to raise awareness of plant risks among the general workforce, via toolbox talks.

- **Implement site / management improvements** by better recruitment and training leading to managers and supervisors with a good knowledge of the industry and relevant site experience. Checks should be carried out on the hearing and eyesight of the workforce. There may not only be problems with the ageing workforce, but also with younger workers who are unaware of the problem. Communicate the safety critical information for plant using checklists etc. so that it does not get lost in the midst of user manuals or other procedures. The implications of fatigue from periods of inactivity whilst specialist hire plant drivers, in particular, wait for their equipment to be needed should be managed. Inappropriate use of mobile phones and radios by workers while operating plant may cause undue distraction in the cab, and their use should be reviewed. Encourage reporting and feedback, and the development of incident management systems.
• **Implement Organisational measures** by establishing consistent priorities throughout organisations to improve culture. Limit the formation of small groups who have different agendas. Ensure that procurement staff have necessary awareness of health and safety issues and/or require site staff to provide full specifications. Provide better education and training of designers including requirements for suitable site experience such that they are more aware of plant requirements and limitations.

• **Enhance Regulatory impact** by providing a clearer lead on issues such as visibility. More dialogue between HSE and industry including the joint development of standards and guidance to encourage a greater degree of ownership and permit new issues to addressed more quickly would be beneficial. The guidance and standards which do exist should be integrated in order to provide a clear and consistent message for equipment purchasers and users. Awareness needs to be raised of the benefits of good health and safety in this area by communicating with construction organisations in the most appropriate language (i.e. costs and benefits).

It is recommended that the following areas should be addressed in order to improve safety in construction goods delivery:

• **Implement training measures to improve competence and awareness** in relation to the risk of low falls e.g. from the cab or trailer. The dangers of fatigue in terms of accidents and general health should be communicated. This should include the risks associated with circadian rhythms and guidance on how drivers can ensure they are adequately rested. Training should cover appropriate manual handling techniques and the effective use of mechanical equipment including how to handle awkward loads in particular.

• **Provide basic information and advice** in drivers’ handbooks and checklists on issues such as unloading and awkward or hazardous loads.

• **Improve planning and communication** by communicating with the site prior to a delivery. Risk assessments should be tailored to specific sites and loads. Operators should be encouraged to consider whether loads can be bundled, put on pallets, preslun or put into whole load containers. Advance communication between the driver and the site should be compulsory.

• **Improve inspection and maintenance regimes** including checks on the general condition of the loading/unloading areas and trailers in order to identify slip, trip and fall hazards. Regular checks of straps and chains should be carried out to make sure they are fit for purpose.

• **The use of additional equipment and PPE issues should be encouraged** for instance: cab steps at the appropriate height with an even distance between them, good grip and clear markings, handholds, operator protection on scissor lifts, vehicle lock in
devices, lightweight demountable ladders, nets around trailers, MEWPS, movable raised loading/unloading docks and use of gloves for carrying and securing loads.

- **Incorporate safety in contractual arrangements**, with the responsibilities of each of the parties made clear.”
APPENDIX D

HAND ARM VIBRATION SYNDROME
UNDERLYING CAUSES AND RISK CONTROL
REPORT VOLUME 4
EXECUTIVE SUMMARY
D. HAND ARM VIBRATION SYNDROME – VOL 4 – EXECUTIVE SUMMARY

“INTRODUCTION AND OBJECTIVES

This report has been prepared by BOMEL Limited for the Association of British Insurers (in conjunction with the Construction Division of the Health and Safety Executive) and describes a study on the underlying influences on and control of Hand Arm Vibration Syndrome (HAVS) risks.

The work described in this report comprises part of Phase 2 of the project ‘Improving Health and Safety in Construction’ the other parts of which have also been carried out by BOMEL. This project follows on from the successful completion of Phase 1 which comprised a pilot study trialing an Influence Network technique to understand the organisational and human factors influencing the health and safety of workers in the construction industry. The approach not only provided new insight to the interrelation of the influences between the parties involved, but it also offered a mechanism for identifying areas where improvements will be effective in reducing risk and for evaluating their potential effectiveness.

The four key objectives of the study are to:

1. Establish, as far as reasonably practicable, an estimate of the likely scale of the HAVS problem in construction from the information and data available such that it can be used to monitor any intervention measures and help to inform subsequent parts of the study.

2. Identify the underlying influences and causes related to HAVS in the construction industry by holding IN workshops with key stakeholders.

3. Identify a variety of risk prevention and control measures in these workshops and ascertain their effectiveness.

4. Generate a set of practical and cost effective risk control options in relation to HAVS which are applicable to the construction industry.

SCALE OF THE HAVS PROBLEM IN CONSTRUCTION

Whilst the effects of safety hazards are relatively immediate and self-evident, the effects of health hazards only tend to manifest themselves in the longer term. As such, health hazards may not be as apparent or have such a high profile as safety hazards but this does not mean that they are any less significant. Indeed, in construction there are more fatalities and illnesses due to work-related disease than there are fatalities or injuries due to accidents each year.

There are two sources of information on the incidence of HAVS available in the public domain: the RIDDOR data collected by HSE and the Industrial Injury Disablement Benefit (IIDB)
Scheme data collected by the Department of Work and Pensions. The RIDDOR scheme is limited by under-reporting, whilst under the IIDB scheme there is very limited eligibility for claims as very few construction activities have been recognised as prescribed activities. There would appear to be a considerable amount of under reporting given that it is estimated that nearly 500,000 construction workers are subject to levels of vibration above the HSE action level whilst the total number of cases of HAVS (vibration white finger plus carpal tunnel syndrome) reported to RIDDOR for all industries was only 1052 in 1999/2000. Notwithstanding the limitations associated with RIDDOR reporting and the IIDB scheme, there may also be the possibility that the action level is low leading to the potential number of construction workers at risk being over-estimated.

Information on claims for HAVS is also likely to be held by individual insurance companies. However, this information is likely to be distorted by the claims process whereby liability is shared between all of a worker’s employers whose work processes are considered to have contributed to the symptoms. Thus one worker’s claim could appear with several insurers.

It is therefore concluded that at the current time it is not possible to determine a definitive baseline for the incidence of HAVS in construction given the limitations of the current reporting systems, the reluctance of workers to report symptoms and the absence of a definitive indicator.

UNDERLYING CAUSES AND INFLUENCES

Three Influence Network (IN) workshops have been held successfully with a wide range of delegates representing the key stakeholders. These workshops generated significant input and discussion, which has been analysed to gain an insight into the underlying influences on HAVS and potential risk control measures. The IN technique provides a means of collating the views of a range of stakeholders to identify the causation of HAVS problems. It also provides a means of identifying critical factors to be addressed as potential risk controls.

Study of the underlying causes indicated that:

- HAVS is primarily a function of exposure to vibration expressed as a combination of time of exposure to vibration (both in terms of hours per day and years of work) and the level of that vibration.

- The functional form for converting exposure to harm is still unknown. There are factors to do with susceptibility, posture, quality and exposure history to be accounted for, as well as impulsive factors. However a simple root mean square (rms) model has been developed using convenient measures of equipment accelerations, and is in current use. The model is not definitive, but suggests that the level of vibration is more significant than the exposure time.

- The medical issues surrounding individual susceptibility to HAVS are also not yet fully understood and agreed. Of those that are agreed, the fact that the effects of HAVS can be reversed if detected early enough is probably the key issue.
Study of the underlying influences indicated that:

- Of the factors that have a Direct influence on HAVS, Inspection and maintenance, and Equipment operability are considered to be the primary influences. Situational awareness / risk perception, Health, Information / advice and Compliance are considered to be the next most significant group of influences. These are followed by Individual competence and Work environment.

- Of the Organisational level factors, the primary influence on HAVS is considered to be Process design. At the next level of significance are Training, Management / supervision, Communications, Health culture and Equipment purchasing. These are followed by Procedures, Planning, Inspection / maintenance and Equipment design.

- Of the Policy level factors, the primary influence is considered to be Health and safety management. At the next level of significance are Company culture and Organisational structure. These are followed by Contracting strategy and Company profitability.

- Of the Environmental level factors, the primary influences on HAVS are considered to be the Regulatory and Market influences.

**RISK PREVENTION AND CONTROL MEASURES**

A number of approaches have been taken in order to identify a series of potential risk control measures including:

- Seeking suggestions from workshop delegates as to what is current good practice both in construction and by looking at other industries / hazards and controls, and what improvements could be made in the future.

- Interrogating the Influence Network to identify the critical factors influencing HAVS in construction.

- Identifying specific examples of good practice already in use in the construction industry both from experience and the literature.

Over a hundred individual risk control measures were generated from these approaches.

It was concluded that designers have the potential to implement the most effective risk controls i.e. to eliminate the hazard by designing it out or to substitute alternative (less hazardous) work processes. However, not all hazardous work processes can be designed out and, as such, the risks need to be minimised by engineering or management controls.

Equipment manufacturers have the potential to implement engineering controls by designing and producing equipment that: vibrates less (thus minimising the vibration level); and is more
efficient (thus minimising the exposure time). It is likely that there would be a time lag before the effects of better equipment were felt. Firstly, there will be the equipment development time. Secondly there is likely to be a considerable take-up time for any new equipment, as many organisations will carry on with their existing equipment until it reaches its replacement date. This suggests that such developments need to be started as soon as possible.

Given the time lag for the introduction and take up of new equipment, in the short to medium-term, and where elimination or substitution are not reasonably practicable, management controls will have to be used to minimise the risks.

PPE in the form of anti-vibration gloves appears to offer little scope for reducing risk due to the level of vibration or time of exposure. The main benefit of gloves appears to be in keeping hands warm and thus maintaining circulation.

Health surveillance can provide a viable risk management option. Although this will not prevent injury, it can be used to detect early signs and prevent worsening of the condition by introducing appropriate risk controls.

**RISK CONTROL OPTIONS FOR THE CONSTRUCTION INDUSTRY**

Consideration of the workshops, discussions, analyses and literature indicates that there are eight key risk control measures which appear to offer the potential for reducing the hazards and risks associated with HAVS in construction. These measures are listed below along with their potential relative risk reduction as determined from analysis of the IN model developed and quantified based on the judgements of the workshop delegates.

- Improvements in process design (40%)
- Improvements in equipment design (25%)
- Increased availability of suitable information on the equipment (15%)
- Increased availability of suitable information on the risks and health issues (15%)
- Increased risk perception among workers (25%)
- Improved inspection and maintenance (45%)
- Increasing the influence of purchasers (35%)
- Increasing the use of health surveillance (30%)

It should be noted that the potential risk reductions from the individual measures are not directly additive due to overlap and synergies. Implementing all of the above measures would lead to a potential reduction in risk of around 80% in relation to the baseline model and influence quantification agreed by workshop delegates.
Of these risk control measures, improving *Process design* and *Inspection and maintenance* appear to offer the greatest potential to reduce risks. The measure associated with improving the information underpins several of the other measures, and should thus be started as soon as possible.

It is also noteworthy that the first seven options are essentially preventative measures, whereas the last (health surveillance) forms part of a more general risk management approach.

**RECOMMENDATIONS**

The key recommendations from this study are based on the eight risk control measures offering the greatest potential to reduce the hazards and risks associated with HAVS in construction:

**Designers** should be targeted to encourage them to eliminate or substitute the hazard and thus reduce both the time of exposure and the level of vibration. The influence that designers can have on either eliminating the HAVS hazard or reducing the HAVS risk needs to be significantly increased from its current level. Whilst there are likely to be a number of issues that need to be addressed in order to increase designer input, the key issue is likely to be designer awareness, both of the potential hazards and risks and of the alternative work processes and tools. Designers need to take a more holistic approach, adding health issues to the vocabulary of design, along with cost, form, function, sustainability, buildability etc. Practical guidance and case studies along the lines of HSG 177 are likely to be required to underpin this measure. Given that the process designers have the opportunity to make such a significant impact, HSE should consider this measure as a high priority in the short-term.

**Equipment manufacturers** should be targeted in order to obtain both reductions in the level of vibration and increases in equipment efficiency (thus reducing the exposure time). This measure is likely to require development work on the part of the manufacturers. However, a driver is required to instigate this work. HSE is in the best position in the to act as a driver initially with potential purchasers and insurance companies providing further drivers once sufficiently reliable information is available to provide meaningful specifications. This measure should be viewed as a key priority in the short-term.

Improvement in the availability of relevant, usable and targeted *information and advice* is required. This will require the involvement of the Regulator, manufacturers and contractors in order to develop that information. This is a major undertaking, but it is one of the key issues as it underpins many of the other risk controls. Once this information is in place, improved compliance can be targeted, inspection and maintenance regimes can be improved, and suppliers will be aware of what to demand from equipment manufacturers. As such, this measure should be viewed as a high priority in the short-term.

Improvements should be made in the *information* provided to workers and organisations on the *risks associated with HAVS* and the associated health and lifestyle issues. Improvements in this information will help to raise awareness and provide the base material for achieving increased risk perception as outlined in the following measure. This should be regarded as a high priority in the medium term.
Raising of situational awareness / **risk perception** among workers is required such that they are more likely to take action themselves. This is likely to require improvements in a combination of Training, Management/supervision, Communications and Health culture. To an extent, this is dependent on having the relevant information on the risks and health issues.

Improvements should be made in **inspection and maintenance** practice such that **equipment** is maintained in good condition thus reducing both the level of vibration and the time of exposure. This is reliant on some of the other risk controls in that information and advice is required such that workers are aware of how to spot any deterioration in performance and the subsequent increase in risk. Compliance with this information is also required. However, these factors can be short-circuited to an extent by encouraging an Inspection and Maintenance Policy that stipulates fairly conservative maintenance periods and procedures in the interim period until further data becomes available.

Purchasers should be targeted such that they are both purchasing the most **suitable equipment** and making the **manufacturers** aware of their requirements for efficient low-vibration equipment. This will improve equipment operability and thus both exposure time and level of vibration. This is likely to require input from the HSE along with the insurance industry in order to influence purchasing policies. However, it does require suitable information in order to develop suitable specifications.

**Increasing** the use of **health surveillance** in construction companies will provide a viable **risk management option**. Although use of health surveillance in a risk management programme will not prevent all degrees of injury, it can be used to detect early signs and prevent worsening of the condition by introducing appropriate risk controls. This should be regarded as a priority in the short-term as the techniques and technologies already exist. The issue is for HSE, and possibly the insurance industry, to encourage increased use of health surveillance.

In addition to the key recommendations on addressing HAVS, a number of other recommendations have been made including:

- The need, in the short term, for articles in the construction press in order to raise the profile of HAVS and the associated hazards.

- In the medium term a guide is required for designers on how to assess and address health issues in construction. This should include information on a range of work processes where HAVS hazards could occur, along with alternative work processes, discussions of the wider costs and benefits and practical case studies.

- Given the success of applying the IN technique in this project, consideration should be given to its application across a wider range of health and safety issues in order to further validate the technique and develop a toolbox of solutions for particular circumstances.

- Having identified ‘*Market influence*’ as being of fundamental important in this work, there is significant potential to explore the sub-influences such as economics and...
finance and their inter-relation in generating risk using the IN, in order that more strategic policy areas for risk management and control can be identified.”
APPENDIX E

FALLS FROM HEIGHT
UNDERLYING CAUSES AND RISK CONTROL
REPORT VOLUME 5
EXECUTIVE SUMMARY
E. FALLS FROM HEIGHT – VOL 5 – EXECUTIVE SUMMARY

“INTRODUCTION AND OBJECTIVES

This report has been prepared by BOMEL Limited for the Construction Division of the Health and Safety Executive and describes a study on the underlying influences on, and control of, falls from height.

The work described in this report comprises part of Phase 2 of the project ‘Improving Health and Safety in Construction’ the other parts of which have also been carried out by BOMEL. This project follows on from the successful completion of Phase 1 which comprised a pilot study trialing an Influence Network technique to understand the organisational and human factors influencing the health and safety of workers in the construction industry. The approach not only provided new insight to the interrelation of the influences between the parties involved, but it also offered a mechanism for identifying areas where improvements will be effective in reducing risk, and for evaluating their potential effectiveness.

The four key objectives of this study are to:

1. Establish, as far as reasonably practicable, an estimate of the likely scale of the falls from height problem in construction from the information and data available such that it can be used to inform subsequent parts of the study and ultimately give a baseline against which to monitor any intervention measures.

2. Identify the underlying influences and causes related to falls from height in the construction industry by holding Influence Network workshops with key stakeholders.

3. Identify a variety of risk prevention and control measures in these workshops and ascertain their effectiveness.

4. Generate a set of practical and cost effective risk control options in relation to falls from height which are applicable to the construction industry.

SCALE OF THE FALLS FROM HEIGHT PROBLEM IN CONSTRUCTION

In October 2000, the HSC established eight ‘Priority Programmes’ within its Strategic Plan. Two of these priority programmes are ‘Construction’ and ‘Falls from height’. These decisions acknowledged the high risks of construction work in general, and of work at height in particular.

Over the last five years around 33% of fatal injury accidents in UK industry occurred in the construction industry, of which 53% were as a result of falls from height. Put another way, around 18% of the fatal injury accidents in UK industry are due to falls from height in the construction industry. The corresponding figures for major accident injuries are 16%, 38% and 6% respectively. Thus, a 66% reduction in the number of falls from height in the construction industry would lead to a reduction of around 12% in the overall number of fatal injury accidents.
and around 4% in major injury accidents. A major reduction in construction accidents and injuries resulting from falls from height would make a significant contribution to achieving the Revitalising targets.

The RIDDOR reported accident data for falls from height has been analysed for the period 1996/97 to 2001/02. Within the bands of the under-reporting of accidents, a baseline of accidents resulting from falls from height can be derived from this data. The new ICC accident data system will make some of the key data fields easier to interpret. In particular, the changes to the ‘Work process’ and ‘Agent’ fields offer extra categories that are more meaningful than the exiting FOCUS system. However, the change to the ICC system does introduce a discontinuity in the accident data from 2001/02 onwards. This means that it is not possible to follow the year-on-year trends for particularly useful fields such as ‘Work process’ and ‘Agent’ from the 1996/2001 data into the 2001/02 data.

Given that the UK construction workload is split, almost equally, between new build work and work on existing structures with each sector having different risk profiles, mechanisms are required in the accident data to separate out new build work from that carried out on existing structures.

Similar sectors, occupations, work processes and agents are involved in both low and high falls, with roofing (high falls) and vehicles (low falls) being the primary exceptions. Carpenters and joiners appear to have the most falls accident. The work process with the largest number of falls is on-site transfer, followed by roofing for high falls. Ladders and scaffolds are most common agents for both low and high falls.

The highest proportion of falls accidents occur among occupations that would not necessarily be associated with working at height i.e. painter, plasterer, glazier, plumber. Given that these trades are well represented in the data for both low and high falls whilst doing the same job, it would suggest that perhaps some of the high fall accidents involving fit-out workers are occurring at heights not much greater than 2m.

Given that typical floor-to-ceiling heights are in the region of 3 to 4m, most fit-out workers will be working at heights up to 2.5m. The current definition of ‘Accident kind’ categorises many fit-out occupations as having had high fall accidents (more than 2m) when, in reality they may not have been working at a height much above 2m. The classification system could usefully be refined to reflect more appropriately the groups of workers such as fit-out workers.

UNDERLYING CAUSES AND INFLUENCES

Three Influence Network (IN) workshops have been held successfully with a wide range of delegates representing the key stakeholders. These workshops generated significant input and discussion, which has been analysed to gain an insight into the underlying influences on falls from height and potential risk control measures. The IN technique provides a means of collating the views of a range of stakeholders to identify the causation of falls from height. It also provides a means of identifying critical factors to be addressed as potential risk controls.

Study of the underlying causes indicated that:
There are essentially two parallel issues: low-level work and high-level work. Whilst there is recognition of the potential for falls during high-level work is high, this is not the case for lower level work.

There is a range of industry practices, with the major clients and contractors at one end, and what might be characterised as ‘white van man’ at the other, with much current practice falling somewhere between.

The phrase that best sums up the typical view of falls from height is: ‘it won’t happen to me’.

Study of the underlying influences indicated that:

- Of the factors that have a Direct influence on falls from height, Competence, Situational awareness / risk perception and Compliance have been readily identified as being amongst the most significant factors. These are followed by Operational equipment, Safety equipment / PPE and Environmental conditions.

- Of the Organisational level factors, the primary influences on falls from height are Training, Management and supervision and Design for safe construction, followed by Planning, Communications and Safety culture.

- Of the Policy level factors, Company culture and Health and safety management stand out as the most significant influences. Given the discussions at all three workshops about the potential (and need) for the client to exert his influence over health and safety, Contracting strategy can be considered as following at the next level of significance.

- Of the Environmental level factors, the Regulatory and Market influences are far more significant than the Political or Social influences overall. However, it was difficult to obtain a consensus view between the workshops as to the specific influence of the Market.

**RISK PREVENTION AND CONTROL MEASURES**

A number of approaches have been taken in order to identify a series of potential risk control measures including:

- Seeking suggestions from workshop delegates as to what is current good practice both in construction and by looking at other industries / hazards and controls, and what improvements could be made in the future.

- Interrogating the Influence Network to identify the critical factors influencing falls from height in construction.
• Identifying specific examples of good practice already in use in the construction industry both from experience and the literature.

Over a hundred individual risk control measures were generated from these approaches.

As hardware and techniques are currently available for safe work at height, the risk controls centred on what should be done to get appropriate design, selection and use of such hardware and techniques. Designers have the potential to implement the most effective risk controls i.e. to eliminate the hazard by designing it out or to substitute alternative (less hazardous) work processes. Not all hazardous work processes can be designed out and, as such, the risks need to be minimised by engineering or management controls. The two key risk control themes thus need to be aimed at Design for safe construction and Site practice.

RECOMMENDATIONS FOR THE CONSTRUCTION INDUSTRY

Consideration of the workshops, discussions, analyses and literature indicates that there are two key risk control themes which appear to offer the potential for reducing the hazards and risks associated with falls from height in construction. These measures are listed below as supported by analysis of their potential relative risk reduction as determined from analysis of the IN model developed and quantified based on the judgements of the workshop delegates contained within the report.

1. Improvements in Design for safe construction require a three-pronged approach in order to address:

• Education and Training for designers involves:
  ➢ Education of undergraduates – by universities in conjunction with industry and HSE as part of the curriculum.

  ➢ Initial and Continuing Professional Development for designers – by the professional institutions, other industry bodies and on-the-job training in order to raise awareness both of the problems and practical solutions.

  ➢ Provision of suitable information and advice - to underpin the education and training initiatives this could be achieved by a combination of industry-HSE guidance and by requiring health and safety issues to be addressed explicitly in codes of practice.

• Mobilising Client influence on designers requires the following issues to be addressed:

  ➢ Education of clients - as to the costs, benefits and legal implications of health and safety via HSE influence on client bodies.
Include health and safety provisions in contracts - this will both raise awareness of health and safety, and impose a civil liability on the parties to the contract. For public procurement contracts, this requires joined-up government.

• Increasing the Regulatory influence on designers requires the following issues to be addressed:
  ➢ Audits of designers compliance with their CDM duties – this will provide HSE with the opportunities both to identify the typical problems that designers have, and provide guidance to designers on how they should be discharging their duties under CDM.
  ➢ Involvement of HSE in the design process – being involved in design team discussions early in the design process can set the tone for the whole project, and provide HSE with the opportunity to influence safety issues at a time when any changes would have most impact with least cost implications.

2. Improvements in Site practice need to take a two-pronged approach in order to address:

• Improving practice requires the following issues to be tackled:
  ➢ Provision of Training and achieving Competence - Training and Information and advice are required such that workers have the necessary skills to carry out the work safely. This Training and Information and advice can come from a variety of sources including site inductions, regular toolbox talks and relevant on the job information on particular tasks.
  ➢ Providing sufficient suitable Management and supervision - these have a key role in improving practice as they provide the direction and control. However, Management and supervision roles have been significantly reduced in recent years with reductions in numbers and the imposition of numerous other tasks. This implies that wider opportunities for exerting Management and supervision influence may have to be sought if the traditional foremen or site managers who may have been present in the past are no longer around.
  ➢ Appropriate selection, use and maintenance of Equipment - whilst the quality of the equipment may be reasonable, the most appropriate equipment needs to be selected in the first place, and then actually used (properly) on site.

• Achieving compliance is likely to be the more difficult issue, and would require the following to be addressed:
Modifying Company culture - Political and Regulatory input are required in order to get the health and safety message over at Duty Holder board level. Communication is required in a language that will be understood.

Improving Safety culture - Management and supervision are key to developing a positive Safety culture, but are highly dependent on having the support with their own Company culture.

Improving Risk perception / Situational awareness - Improving Risk perception / Situational awareness requires the provision and Communication of appropriate Information and advice to the workforce such that they appreciate the risks and do not feel that ‘it won’t happen to me’.

3. Awareness of the risks associated with low-level falls needs to be raised

- Low falls contribute around two-thirds of the non-fatal construction accidents and injuries due to falls. A large number of these falls occur in fit-out and maintenance trades where working off ladders and platforms is seen as an everyday activity with little associated risk or specific safety training. Awareness of the potential problems needs to be raised in the first instance.

REMAINING ISSUES

In addition to the key recommendations on addressing falls from height, a number of other recommendations have been made for further work necessary to underpin the key recommendations and provide a basis for detailed implementation plans. These include:

- Further work to understand the situation relating to Design for safe construction, in particular, what the key mechanisms are to improving the treatment of health and safety in relation to work at height throughout the construction life-cycle by designers.

- Further work to investigate the routes to improving the Safety culture within the construction industry. Such work would need to address the underlying drivers for both organisations and individuals in order to understand the complex human and organisational issues that underpin cultural change.

- The issues surrounding low-level falls, particularly in relation to fit-out and maintenance work, need to be investigated in greater detail in order to determine the best routes to raise the level of perception of the everyday risks associated with working at (low) height such as painters, plasterers, electrical fitters etc.
Having identified the ‘Market influence’ as being of fundamental importance in this work, the Influence Network could be used further to explore the elements of market influence such as insurance, economics and finance to identify their inter-relation in affecting the decision making and actions with regard to health and safety taken by employers. This would help enable the routes for more strategic policy areas for risk management and control to be identified.”
APPENDIX F

GENERIC MODEL FOR HEALTH AND SAFETY IN CONSTRUCTION

REPORT VOLUME 6

EXECUTIVE SUMMARY
F. GENERIC MODEL FOR HEALTH AND SAFETY IN CONSTRUCTION – VOL 6 – EXECUTIVE SUMMARY

“INTRODUCTION AND OBJECTIVES

This report has been prepared by BOMEL Limited for the Construction Division of the Health and Safety Executive and describes a study of health and safety in construction and looks at a generic model for assessing the influences on risk.

The work described in this report comprises part of Phase 2 of the project ‘Improving Health and Safety in Construction’ the other parts of which have also been carried out by BOMEL. This project follows on from the successful completion of Phase 1 which comprised a pilot study trialing an Influence Network technique to understand the organisational and human factors influencing the health and safety of workers in the construction industry. The approach not only provided new insight into the interrelation of the influences between the parties involved, but it also offered a mechanism for identifying areas where improvements will be effective in reducing risk, and for evaluating their potential effectiveness.

The four key objectives of the study reported in this volume are to:

1. Consolidate the Influence Network models from the other project activities to identify common industry themes and key factors whose influence definition and quality vary with accident type. Identify supplementary factors for recording in incident investigations.

2. From the Influence Network workshops involving organisations with a high profile safety focus, identify risk controls contributing to differentials from industry ‘norms’. These may act as prompts in more general applications of the generic model.

3. Document the rating differences between baseline and ‘best’ practices identified in the other project activities to provide a basis for users of the model to benchmark their own assessments of performance.

4. Document the generic model and application methodology as a tool kit for third party use.

DEVELOPING A GENERIC MODEL FOR CONSTRUCTION HEALTH AND SAFETY

The generic model has been based on an Influence Network which sets the accident types or ill-health directly affecting individuals in the context of the construction work environment, their actions and the available hardware. It highlights the chain of influence, not just from the way work is organised on site but to the policy influences from parent companies or through the supply chain of contractors, designers and clients within the overall environmental context of the industry as shaped by political, regulatory and market factors.
It has been possible to customise the Influence Network for both health and safety issues including: hand-arm vibration syndrome, falls from height (new build and existing structures), construction plant, roadworks and goods delivery. Specific issues and the overall methodology have been drawn out in order to develop a Generic model for construction health and safety, with generic factors for the Environmental, Policy, Organisational and Direct levels of the Influence Network.

The factors at the Environmental and Policy levels are likely to be generic for most aspects of health and safety. However, some of the factors at the Organisational and Direct levels would need customisation in order to reflect the specific issues of an aspect of health or safety. Such customisation would be in terms of factor definitions or one or two more or fewer factors, typical examples being:

- With specific health issues, the Health factor definition may need customisation to reflect an individual’s likelihood of suffering (i.e. distinguishing pre-disposition or health brought to the job, from health effects arising from the work activity).

- With health and safety issues that are heavily influenced by aspects of equipment use, such as hand-arm vibration syndrome, an extra factor Equipment design is required at the Organisational level.

- For some areas such as roadworks there may be little to distinguish Internal and External working conditions. However, for other issues such as plant the two will be very distinct (e.g. conditions in the cab compared with the general conditions and terrain).

- With some areas such as roadworks, there is a parallel set of issues to be considered relating to the effects of the public as car drivers whose actions can create a hazard. The Influence Network factors provide a basis for identifying the factors relevant to drivers and focussing the discussion to suit.

The Influence Network offers the inherent flexibility to deal with the primary routes of causation where these are reasonably well-defined for a given top event. For instance, HAVS was assumed to be a function of level of vibration and time of exposure, but these two components were influenced by different factors leading to two paths through the Influence Network.

The analysis of the Influence Network is relatively straightforward, with simple techniques available to identify critical factors and paths. The analysis methodology can be customised to allow factors such as Design to be modelled in such a way that their full and fundamental impact can be allowed for, and to reflect the contributory factors to a health issue such as hand-arm vibration syndrome. This can be achieved without distorting the results obtained in the workshops significantly, or requiring excessive input or judgement to be applied by the project team.
The Influence Network methodology can be used to identify and evaluate potential risk controls. Several complementary methods of identifying risk controls in relation to the Influence Network are presented.

IDENTIFYING HEALTH AND SAFETY BEST PRACTICE WITH A VIEW TO BENCHMARKING PERFORMANCE

At each of the Influence Network workshops, organisations with well-developed safety systems representative of industry good practice were in attendance. Specific examples of best practice and risk controls were provided by these organisations.

Based on the input of the workshop participants, it was possible to obtain indications of what the ranges of best to worst practice were for both health and safety issues. This allows third party organisations to benchmark themselves against industry best practice and monitor improvement with time. Alternatively the basic Influence Network factor definitions and rating scales presented give a basis for measurement and monitoring.

The best practice ratings for the health issue considered appeared to be somewhat lower than those for the safety issues, perhaps reflecting the greater awareness of what can be done to address safety. However, more good practice suggestions were generated for health issues than safety, perhaps reflecting the fact that specific measures are required for health issues, whereas best practice for safety is more apparent. It may also be that the range of health controls indicates relative uncertainty about what might work whereas in safety thinking and experience are more mature with focus now reduced to a smaller number of ’required’ actions.

GENERIC MODEL FOR CONSTRUCTION HEALTH AND SAFETY

A Generic model for construction health and safety is presented in this report along with a methodology indicating how the Influence Network model can be used by third parties to support health and safety planning and performance measurement.

RECOMMENDATIONS FOR THE CONSTRUCTION INDUSTRY

The Generic model for construction health and safety outlined in this report can be used by organisations (or groups of organisations) within the construction industry to evaluate and benchmark their current health and safety performance with a view to identifying potential measures for continuous improvement.

Ongoing application of the Influence Network to a wide range of health and safety issues will further validate the technique and consolidating the findings would enable the toolbox of solutions for generic and particular applications to be developed. If the results of such studies were pooled on a wider basis, the construction industry would have a better picture and more consistent insight to the current situation along with examples of what best practice is available.
Whilst use of the Influence Network technique has proved successful in this project, it is recognised that further work could be undertaken to develop some of the concepts and issues identified. In particular, work is required to ascertain how Design for safe construction at the Organisational level could best be integrated into the Influence Network model such that its significance is always reflected appropriately in the analysis. Such an approach may require parallel Influence Network models addressing ‘design’ and ‘site’ issues or a clearer demarcation between construction parties.

The Influence Network technique has been successful in moving the focus from the conduct of work activities to the wider circumstances through which risks are generated and where strategic risk management controls are needed. It is therefore considered appropriate for the Influence Network technique to be used as a basis for developing more detailed insight into the nature and role of Market influences as this was considered to be of fundamental importance by the workshop delegates, but few examples of potential controls or responses were identified. All aspects of economics, finance, insurance and risk would need to be considered in relation to the industry structure(s) and business practices to understand how and why they have influence. This would allow other policy areas that may be influential in risk management such as corporate governance and the tensions between risk transfer and risk retention to be investigated. This understanding could be particularly important to ensure the health and safety developments in the industry are insulated from future market cycles.”
APPENDIX G

ANALYSIS OF HSE MECHANISMS

REPORT VOLUME 7

EXECUTIVE SUMMARY
G. ANALYSIS OF HSE MECHANISMS– VOL 7 – EXECUTIVE SUMMARY

“INTRODUCTION AND OBJECTIVES

This report has been prepared by BOMEL Limited for the Construction Division of the Health and Safety Executive and describes a study of health and safety in construction in relation to HSE’s perceptions of the issues and its mechanisms for addressing those issues.

The work described in this report comprises part of Phase 2 of the project ‘Improving Health and Safety in Construction’ the other parts of which have also been carried out by BOMEL. This project follows on from the successful completion of Phase 1 which comprised a pilot study trialing an Influence Network technique to understand the organisational and human factors influencing the health and safety of workers in the construction industry. The approach not only provided new insight into the interrelation of the influences between the parties involved, but it also offered a mechanism for identifying areas where improvements will be effective in reducing risk, and for evaluating their potential effectiveness.

The four key objectives of the study are to:

1. Define HSE interventions / activities in the context of the construction industry taking account of the intervention strategy.

2. Convene an HSE workshop comprising Construction Division staff to agree the definition and extent of HSE functions, the current rating and relative weighting / significance on stakeholders within the construction industry.

3. Analyse the Influence Network to identify areas where changes may be particularly effective but incorporating a measure to ensure balance and reflect statutory duties.

4. Report, documenting use of model to support strategy planning and performance measurement.

HSE INTERVENTION MECHANISMS FOR THE CONSTRUCTION INDUSTRY

The current and future HSE interventions have been identified from the published intervention strategy for the Construction Division. The interventions are considered in relation to the following key health and safety themes amongst others:

- Falls from height.
- Transport.
- Cement dermatitis.
- Hand arm vibration syndrome.
- Exposure to noise.
- Exposure to musculoskeletal injury.
Current emphasis on the ‘High 5’ (site tidiness & welfare; falls from height; manual handling; transport; and asbestos) particularly for small businesses is noted.

The interventions will be aimed at the following key stakeholders:

- Government – as a client.
- Clients, designers and planning supervisors – particularly on larger projects.
- SMEs and sole traders – to raise awareness and improve competence.
- The workforce - to raise awareness and improve competence.
- Manufacturers – to reduce risks through design and ensure provision of suitable information.

Discussions at the Intervention mechanisms workshop focussed on the previous intervention mechanisms used by the HSE in relation to construction. These could broadly be categorised as being:

- Traditional interventions – including regulations and enforcement.
- Guidance mechanisms – guidance, code and standards, safety awareness days, industry forums and advice.
- CDM goal setting mechanisms – mechanisms for complying with the health and safety at work act, and participation in design or site meetings.
- Hardware regulations – prescriptive regulations including CHSW.

UNDERLYING CAUSES AND INFLUENCES

A two-day accident and ill-health causation workshop was held with members of the Construction Division, and an Influence Network was quantified along with discussions of the underlying reasoning. The key underlying causes and influences were felt to be as follows:

- The construction industry is very much dominated by the ‘just get it done’ culture, where reputations are made or lost on the ability to deliver.
- *Risk Perception* and *Situational Awareness* are heavily influenced by the underlying culture as workers were felt to know what the problem was, but did not appreciate its significance thinking ‘it won’t happen to me’.
- Changing the construction industry culture to include health and safety was felt to be one of the key improvements needed.
• **Compliance** tends to be with what the workers consider to be the most important issue/culture. Typically, this is ‘get the job done by the deadline’ rather than ‘get the job done safely’.

• The skills shortage has lead to companies employing less skilled (or suitable) workers than they did in the past leading to a subsequent dilution of skills on site. Thus some companies are taking on work that they do not have the necessary competencies to undertake.

• Procedures and plans tend to be viewed as a burden to be completed to satisfy the client/HSE requirements rather than to help get the work done. Whilst the letter of the regulations (such as CDM) may be complied with, the spirit is not.

• Site management is typically left to sort out the problems in order to get the job done.

• **Management and Supervision** are considered to be critical to improving health and safety in construction. However, they tend to be impeded by a lack of Training, experience and Competence; having so many other issues to deal with; having multiple trades working simultaneously; and the fact that there are so few supervisors for the work required.

• The **Information and Advice** getting to the workforce is poor. Information from risk assessments (where they exist, and are relevant) does not make its way to the workforce.

• Poor **Communications** were often cited as being major contributors to accidents.

• **Design for Safe Construction** was felt to be poor with a lack of interest amongst designers. Improving this factor was felt to be an uphill struggle.

• Clients need to exercise more influence by including health and safety requirements explicitly in contracts. This way a civil liability would be introduced, and **Compliance** would be more likely. (The government would have a good opportunity to do this with forthcoming infrastructure projects).

• The construction industry has a multiplicity of drivers including cost, time and conditions. These dominate the thinking, and the situation is getting worse with the continual client pressure for reductions in construction time.

• Along with **Company Culture, Health and Safety Management** was felt to be the most important Policy level factor. However, there was felt to be a greater need for a culture more so than system, given that a safety management system will follow from the culture.
There is a disparity in resources between HSE and the construction industry, but HSE were felt to be effective due to the approach taken and the respect for HSE within the construction industry.

MODEL TO SUPPORT STRATEGY PLANNING AND PERFORMANCE MEASUREMENT

A methodology has been presented indicating how the Influence Network model can be used to support strategy planning and performance measurement. The quantified Influence Network model developed during this project can be used to re-test the findings of the previous evaluation exercise based on the ratings and weightings on a variety of health and safety issues from the research in this Phase 2 project as a whole.

AREAS FOR CHANGE

Both quantitative and qualitative analyses of the Influence Network have been undertaken in order to identify potential areas for change. These indicate that there are five key risk control measures that appear to offer the potential for reducing the hazards and risks associated with construction when used in addition to, or to underpin, the components of the intervention strategy. These measures are listed below and estimates of their potential relative risk reduction are made in the report:

- Improvements in design for safe construction
- Additional routes to target smaller companies
- Demonstrate the economic benefits of better health and safety
- Raising the awareness of the intent health and safety duties and appropriate controls
- Increasing Risk perception and Competence among workers.

RECOMMENDATIONS

Consideration should be given to implementing the following five risk control measures in addition to, or to underpin, the components of the proposed intervention strategy.
1. **Improvements in Design for safe construction**

A three-pronged approach is required in order to address:

- *Education and Training* for designers
- *Client influence* on designers
- *Regulatory influence* on designers

**Education and Training for designers** requires:

- *Education of undergraduates* – by universities in conjunction with industry and HSE as part of the curriculum on higher education courses.

- *Initial and Continuing Professional Development for designers* – by the professional institutions, other industry bodies and on-the-job training in order to raise awareness both of the problems and practical solutions.

- *Provision of suitable information and advice* - to underpin the education and training initiatives this could be achieved by a combination of industry-HSE guidance and by requiring health and safety issues to be addressed explicitly in codes of practice.

Mobilising *Client influence on designers* requires the following issues to be addressed:

- *Education of clients* - as to the costs, benefits and legal implications of health and safety via HSE influence on client bodies.

- *Inclusion of health and safety provisions in contracts* - this will both raise awareness of health and safety, and impose a civil liability on the parties to the contract. For public procurement contracts, this requires joined-up government.

**Enhancing the Regulatory influence on designers** requires the following issues to be addressed:

- Audits of designers’ compliance with CDM – this will provide HSE with the opportunities both to identify the typical problems that designers have, and provide guidance to designers on how they should be discharging their duties under CDM.

- *Proactive intervention at the beginning of a project* - when it is easier to make a substantial impact and the designer is less resistant to change.

- *Utilise computer-aided learning (CAL)* - as a means of communicating health and safety information to undergraduates (as part of their education) and professionals (as part of their initial and continuous professional development).
2. **Targeting of smaller companies**

Additional means of targeting smaller companies include:

- The use of Customs and Excise as a means to identify smaller companies involved in construction or maintenance work via VAT returns.

- Use Builders merchants and hire shops as a route to disseminating information to smaller companies.

- Use manufacturing and other companies who employ small maintenance companies as a route to target these smaller companies (either as a means of disseminating information or including health and safety in the contract procurement strategy).

- Consider prescription/risk assessment for small companies, say targeted at seven or so key areas (to make it easier for them to understand and comply).

3. **Demonstrate the economic benefits of better health and safety**

Cost is an integral part of the current construction culture in the UK, and any messages about health and safety need to recognise this. As such, the economic benefits of good health and safety need to be demonstrated to those who do not currently appreciate this. Real life case studies and examples are required in order to demonstrate what the real costs and benefits are. In this way, health and safety can be communicated in a way compatible with the prevailing culture. This could go some way to improving *Company culture* and thus drive down an influence from the top of organisations.

4. **Raising awareness of the intent of health and safety duties and appropriate controls**

Until those with high-level responsibility within organisations appreciate what they need to be doing, it will be difficult to get them to actually fulfil those duties. There is a need for the *spirit* of the regulations to be complied with as well as the letter i.e. relevant risk assessments leading to meaningful method statements applicable to the hazardous elements of the work to be carried out. The proposed actions could be incorporated into the advice, inspection and enforcement activities of the Construction Division, in particular when concentrating on the specific health or safety themes noted in the report.

- Raise awareness of the purpose of risk assessments and where they should be carried out (i.e. with particular focus for the hazardous activities rather than the straightforward activities).

- Raise awareness of the link between risk assessments and method statements.

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• Take a tougher line on the use of generic risk assessments and method statements that bear little relevance to the key hazards on a project.

5. **Increasing Risk perception and Competence among workers**

Action is required at several levels in order to tackle the *Risk perception* and *Compliance* issues. Action is required at board level in order to underpin actions further down the chain and set the overall culture. This implies a staged process. Obviously, this highly complex and difficult area requires considerable attention in its own right in order to understand the underlying cultural driver. However, Inspectors could be used to promote the message as part of their duties. The following issues that would need to be addressed:

• **Modifying Company culture** - *Political* and *Regulatory* input are required in order to get the health and safety message over at Duty Holder board level. Communication is required in terms that will be understood and significant to the businesses (see Recommendation 3).

• **Improving Safety culture** - *Management and supervision* are key to developing a positive Safety culture, but are highly dependent on having the support from the overall *Company culture*.

• **Improving Risk perception / Situational awareness** - Improving *Risk perception / Situational awareness* requires the provision and *Communication* of appropriate *Information and Advice* to the work force such that they appreciate the risks and do not persist thinking that ‘it won’t happen to me’.

Whilst use of the Influence Network technique has proved successful in this project, it is recognised that further work is required in order to develop some of the concepts and issues identified in this project. In particular, further work is required to understand the situation relating to *Design for safe construction* in terms of what the key levers are to improving the treatment of health and safety in design. Having identified the ‘*Market influence*’ as being of fundamental important in this work, there is a significant need to explore sub-influences such as economics and finance and their inter-relation in generating risk using the Influence Network, in order that more strategic policy areas for risk management and control can be identified in relation to potential HSE interventions. This will help ensure health and safety action will be effective in the context of construction business activity.”