Trojan horse construction site safety messages

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This study was commissioned by the Health and Safety Executive to assess the efficacy of a novel means of messaging that delivers safety information directly to site operatives. The method involved attaching key messages to construction components.

The background to this study stemmed from the HSE Falls from Height Programme. The study was sponsored by the Health and Safety Executive and involved The Steel Construction Institute, BSRIA and The Concrete Society under the Co-Construct umbrella.

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EXECUTIVE SUMMARY

This study was commissioned by the Health and Safety Executive to assess the efficacy of a novel means of messaging that delivers safety information directly to site operatives. The method involved attaching key messages to construction components. The overall rationale and methodology adopted for the project are presented in section 2.

The approach comprised an incident analysis and selection of key messages for the various construction types and is described in section 3.

Section 4 addresses the subsequent design of the content of the messages and the messaging media.

Arriving at the practical implementation of the messages involved significant input from the participating companies as described in section 5.

The impact of messaging was measured in terms of the awareness of operatives and level of information uptake detected. This was assessed through on site survey. The design of the survey questionnaire and the trial surveys are described in section 6 and the full site survey is described in section 7.

The outcomes of the survey indicated that operatives showed high awareness and high levels of information uptake as described in the analysis undertaken in section 8.

Having delivered positive results, consultation was undertaken to examine how the outcomes could be practically implemented. This included discussions with a wider industry group and estimation of cost and these are summarised in section 9

The project outcomes are summarised in Chapter 10.

1 INTRODUCTION

The construction industry in the UK has been the subject of several high profile initiatives recently namely Rethinking Construction [1], Accelerating Change [2], Revitalising Health and Safety in construction [3] and the Working Well Together Campaign. However, as pointed out by Kevin Myers, Chief Inspector of Construction (Health and Safety Executive), "….*convincing evidence for a downward trend in the number of injuries (both fatal and non-fatal) has yet to be established*." [4].

The construction industry employs just over 6% of the UK workforce but accounts for over 30% of the fatal injuries and over 14% of the major injuries [5]. The Health and Safety Commission (HSC) national statistics [5] for the construction industry show that:

- Construction accounted for 67% of all fatalities to workers as a result of falls from height in 2002/03p (p denotes provisional figures).

- Ladders and roofs were the most commonly cited agents associated with fatalities due to high falls (2m or above) with ladders and scaffold the most common agents for low falls (up to and including 2 metres).

- During the period 1996/7 – 2002/3p, the construction industry has the highest number of falls for both employees and self-employed. In all years, the construction industry accounts for more than half of all fatalities due to falls from height.

The HSC Strategic Plan 2001/2004 [6] identified eight priority programmes where improvements are needed. Falls from height is one of the major programmes within the HSC strategic plan and the involvement of stakeholders is crucial to help deliver the targets.

1.1 BACKGROUND

The background to this study stemmed from the HSE Falls from Height Programme. The study was sponsored by the Health and Safety Executive and involved The Steel Construction Institute, BSRIA and The Concrete Society under the Co-Construct umbrella.

Recent Co-Construct Research [7] had demonstrated that 'best practice' messages could be effectively delivered to small and medium companies and individual decision makers by using 'Merchant Messages'. The project used messages in point of sale information to bring best practice information to small and medium enterprises and site operatives and took into account the fact that site level operatives do not have access to main stream documentation to refresh awareness of basic health and safety practice. Knowledge of general good practice may have been developed through standard training but custom, practice and time constraints often conspire against safe practice.

This project proposed the use of similar tactics to bring positive safety messages to site operatives using messages on the medium they routinely work with; hence the term 'Trojan Horse' messages. The Project examined the effect of simple safety messaging applied to construction components as a way of delivering relevant safety advice to site operatives and raising awareness of risk factors at the point of delivery.

Borrowing from the Construction Best Practice Programme [8], a methodology in which best practice messages were positively endorsed at operative level by a 'Trojan Horse' method that used novel means of presenting messages directly to site operatives. These messages related to

particular ‘risk factors’ associated with the activities covered. They were written in simple plain language and were carried to the operatives by applying them to the components that the operatives routinely worked with.

1.2 OBJECTIVES

The primary aim of the project was to assess the efficacy of the Trojan Horse messages in delivering health and safety information directly to site operatives. It was proposed to achieve this aim by:

- Using links with trade associations to identify particular ‘high value’ safety messages;
- Using links with component manufacturers to bring component based methods to site;
- Designing and discharging out site surveys to assess:
    - The level of awareness of the operatives
    - The information imparted to the operatives by the messages

In addition, based on the findings of the survey, the project also aimed at:

- Drawing conclusions on observable differences in working with and without Trojan Horse messaging.
- Providing recommendations on the practical implementation of the Trojan Horse messaging
- Addressing cost issues associated with large-scale application of the Trojan Horse messaging.

1.3 SCOPE OF STUDY

To achieve the above objectives, the study was split into several stages as follows:

a) Identify a small number of consistent risk messages associated with the following construction types:

    a. Steel frame erection;
    b. Profiled sheet steel permanent slab formwork;
    c. Pre-cast concrete decking applied to structural framing;
    d. Trussed-rafter roof erection.

b) Assemble partner contractors and fabricators willing to apply the site messages to product components.

c) Design and test an easily applied face-to-face survey.

d) Apply the survey in comparative site trials i.e. on ‘messaged’ and ‘non-messaged’ sites

e) Analyse the operative feedback on the awareness, interest and influence of the messages.

f) Provide recommendations on the influence of Trojan Horse messaging, in particular, highlighting the practical differences in levels of awareness of site hazard and providing information on the organisational issues arising from attempting to extend the messages.

2 METHODOLOGY

This study aimed at assessing the efficacy of the Trojan Horse messaging in delivering health and safety information directly to site operatives. To achieve this objective, it was crucial to enlist the participation of industry stakeholders to advise on the methods and procedures adopted for the study; hence, the appointment of a peer reviewer and the formation of a steering group.

2.1 PEER REVIEWER

Adrian Terry of Halcrow Group (formerly of Rethinking Construction) was appointed as peer reviewer with the following role:

a) To critically appraise the project methodologies before declaration to the Steering Group and before committal,

b) To appraise intermediate results in the form of draft reports and

c) To provide mentoring advice on procedures and deliverables before committal.

2.2 STEERING GROUP

The steering group comprised of five senior health and safety representatives from various construction sectors (Table 1) with the following remit:

a) To provide focus and direction to the study,

b) To critically appraise the methodology adopted for the study particularly in relation to the various construction types

c) To advise on issues raised by the peer reviewer and the working group.

Table 1 Steering group members

Name	**Company**
John Carpenter (Chairman)	Private consultant in construction health and safety; Secretary to SCOSS
Paul Turrell	Taylor Woodrow; Head of Safety
Roger Pope	Roger Pope Associates; Health and Safety advisor to the British Constructional Steelwork Association
Mike Stott	Laing O'Rourke; Head of Safety
Chris Shelton	Dover Trussed Roof Co. Ltd; General Manager

2.3 METHOD STATEMENT

The methodology adopted for the study was as follows:

a) Identification of safety issues relating to the selected construction types (steel framing, steel decking, precast concrete flooring and truss rafters). The safety issues were identified from reports from the relevant trade associations (Section 3)

b) Design of messages and messaging media for each of the construction types. The messages were related to the safety issues identified in (a) and were designed as cartoon illustrations with minimal text (Section 4).

c) Design of survey questionnaire to assess the mix of variables identified for the study (Section 6).

d) Carry out trial surveys on a 'messaged' and a 'non-messaged' or control site to test the messages and the survey questionnaire (Section 6).

e) Updating of survey questionnaire based on trials. The lessons learned from the trials were used to fine-tune the messages and the questionnaire (Section 6).

f) Carry out site surveys on 14 'messaged' and 8 'non-messaged' or control sites (Section 7).

g) Data collection and survey analysis (Section 8)

h) Final report.

2.4 TIMELINE

The methodology and timeline for the study is shown in Figure 1. The project started with a meeting of the working group members (The Steel Construction Institute, BSRIA and The Concrete Society) and the Health and Safety Executive project officer on the 23rd of July 2003 where the strategy for the direction of the study was agreed.

The first Peer Review and Steering Group meetings were held in October 2003 to discuss and advise on the methodology and details of messages and messaging media. The design of the messages and the survey questionnaire were completed in early February 2004. The site trials were carried out on 2 'messaged' sites in Didcot and Harlow and on 1control site in the Isle of Grain. The second Peer Review and Steering Group meetings were held in March 2004 and addressed the issues raised during the site trials.

Site surveys were carried out on 12 messaged sites and 8 control sites by trained field engineers from The Concrete Society. The third Peer Review and Steering Group meetings were held in August 2004 and addressed the preliminary results from those surveys, which showed high levels of awareness and information uptake of the messages by the site operatives.

Following recommendations from the Steering Group, it was deemed crucial to disseminate the results of the study to the wider industry. A meeting was subsequently held with the industry stakeholders, which included various trade associations and members from the Major Contractors Group, at the Institute of Materials, Minerals and Mining on the 24th of September 2004.

The results from the study generated positive feedback from the industry and endorsed the technique. The recommendations from the meeting are discussed in Section 9.

2.5 PARTICIPATING COMPANIES

The success of the Project relied heavily on the assistance of companies both for the application of the messages and the provision of sites to conduct the surveys.

All the companies who were approached for assistance expressed a keen interest in the study and provided valuable advice that facilitated the process. The list of participating companies is shown in Table 2.

Table 2 Participating product supply companies

Construction Type	**Company**
Steel frame erection	Bourne Steel
	Frank H Dale
Precast components	Tarmac Topfloor
Profiled steel decking	Corus Panels and Profiles/Studwelders Ltd
Trusses rafters	Dover Trussed Roof Co. Ltd

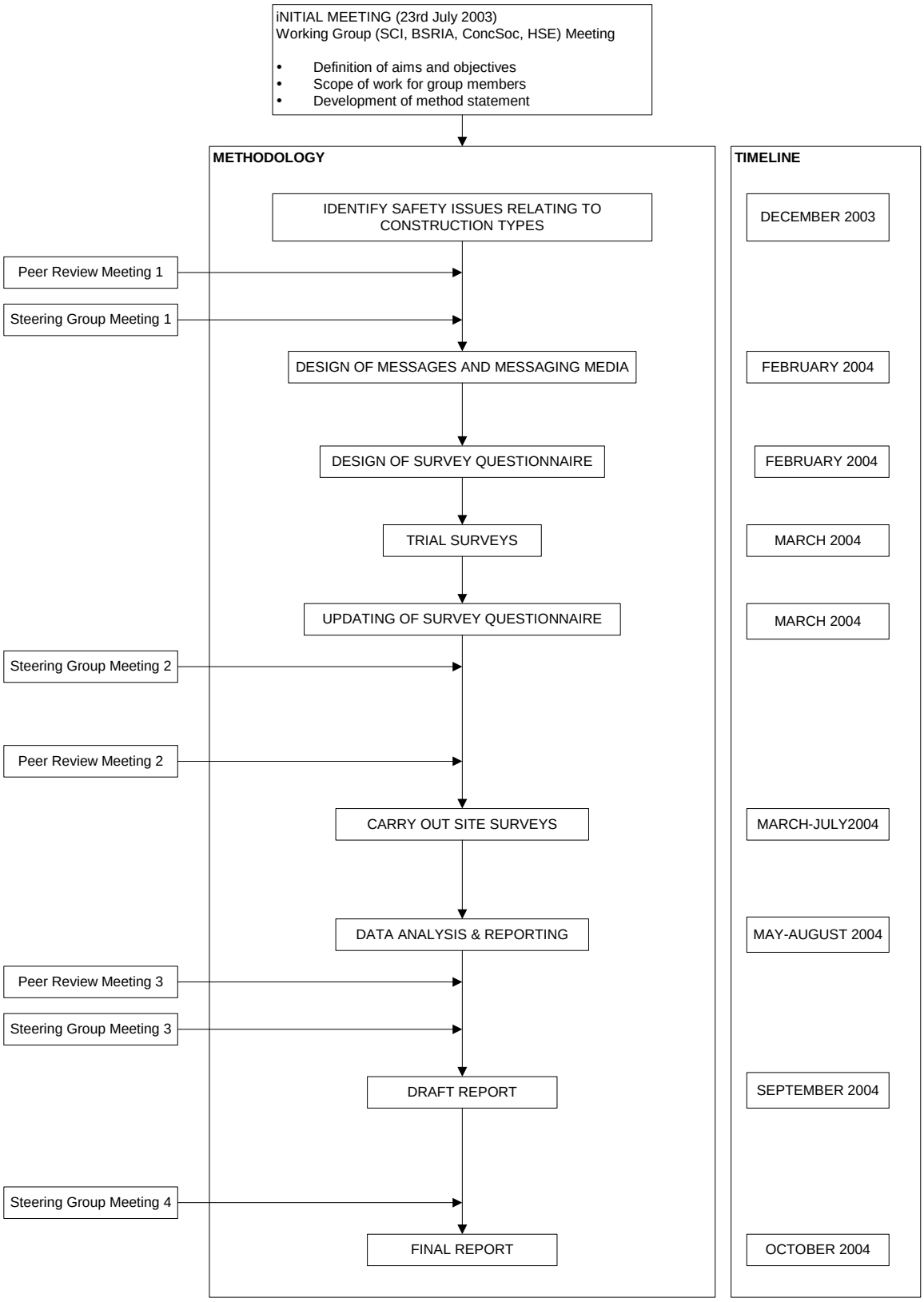

Figure 1 Flowchart showing method statement for Trojan Horse Project

3 INCIDENT ANALYSIS AND SELECTION

The safety issues addressed within the context of this study were specific to steel frame erection, installation of profiled sheet steel permanent slab formwork, installation of pre-cast concrete decking applied to structural framing and trussed-rafter roof erection.

A recent study by Gibb [9] on the causal factors in construction accidents found that over two-thirds (70%) of site accidents arose from worker actions which pointed to inadequate supervision, education and training. In addition, the study noted that nearly half of the accidents resulted from poor housekeeping and problems with the site layout. This suggests that incidents are caused by the latter commonplace hazards rather than specific hazards relating to erection and installation of components.

Following advice from the steering group, it was decided to address safety issues specific to the various construction types rather than generic safety issues (e.g. site untidiness). Although the specific issues only occasionally result in accidents, the consequences associated with those accidents are, however, more severe than those arising from general issues.

In addition, based on the scope of the study and the recommendations from the steering group, only one safety issue was addressed for each of the construction types albeit several issues, which can be used for Trojan Horse messaging, were identified and are listed below.

The use of a single safety issue for each construction type facilitated the design of the survey and reduced the number of variables that had to be accounted for. In addition, the objective of the study was to test the awareness and information uptake of the site operatives and not the message itself.

3.1 STEEL FRAME ERECTION

Identification of safety issues for steel frame erection was based on published guidance from the British Constructional Steelwork Association (BCSA) [10] and from SCI P-162 [11].

Under CDM regulations, designers are required to give due regard to health and safety; to avoid, reduce or control the hazards. However, hazards may occur irrespective of the design solution adopted and many fall outside the designer's influence. The Trojan Horse messaging was directed at those particular hazards, which were under the control of the site operatives.

The selection of the safety issue was based on industry-wide records as reported in the BCSA [10] and SCI P-162 [11] publications. The hazards considered within the context of this study falls under the 'exposure to a moving (including falling) object' category and include:

Falling Objects

- Components slip out of sling
- Roof sheets falls
- Steel falls off delivery lorry
- Hand tools dropped
- Steel dropped during manual handling

- Lifting gear breaks

Moving Objects

- Roof sheets blown by wind
- Wind blows steel in hook
- Slip under load
- Failure whilst jacking or winching

Several other commonly encountered hazards in construction are listed in the referenced publications. From consultation with the industry stakeholders and the HSE, the slinging issue (i.e. components slip out of sling) was selected as the Trojan Horse message for steel frame erection.

3.2 PROFILED STEEL DECKING

Profiled steel decking is used as permanent formwork to concrete forming a composite slab. The slabs are most commonly used in industrial and commercial steel buildings although they may also be supported off brick, masonry or concrete components [12].

The safety issues arising from the installation of profiled steel decking is also addressed in the BCSA [10] and SCI P-162 [11] publications. In addition, the Metal Cladding and Roofing Manufacturers Association (MCRMA) publication [12] and SCI P-090 [13] document provides detailed guidance on the design, storage, handling and installation of profiled steel decking.

The common hazards associated with installation of profiled steel decking are [10, 11, 12, 13]:

- Floor decking falls or blown by wind
- Falling through decking from inadequate resistance of decking or support
- Falling through penetrations from lack of adequate edge protection
- Contact with hot particles during stud welding
- Collapse of decking from overload during concreting
- Collapse of decking due to overload from bad storage of materials

Based on recommendations from the industry stakeholders and the HSE, the issue initially selected for the Trojan Horse messaging was the hazard caused by floor decking blown by wind as may occur from improper stacking of loose sheets at heights.

However, following feedback from manufacturers, the message was subsequently altered to reflect their concern regarding the overload of steel decking from bad storage of materials. This is discussed further in section 4.2.

3.3 PRECAST COMPONENTS

Precast components are heavy and are commonly encountered in all types of structures (steel, masonry or brickwork/blockwork). The Precast Flooring Federation code of practice [14] identified several safety issues relating to the installation of precast components. These can be summarised as follows:

- Lifting, handling and placing of units
- Imposed loads during installation
- Stability of supporting structures during installation

The supporting structure in the latter case can be steel framing, masonry or brickwork/blockwork. For steel framing, the steel sections must be properly fixed and propped prior to installation of the precast components. For masonry structures, sufficient curing time must be allowed so that the mortar develops adequate strength. In addition, unstable and inadequate bearing support can lead to failure.

Again, based on recommendations from industry stakeholders and the HSE, the safety issue selected was the stability of steel framing structure prior to installation of precast components.

3.4 TRUSSED RAFTER

The Truss Rafter Association (TRA) Technical Handbook [15] provides detailed guidance on the handling, storage and erection of truss rafters. The safety issues identified with respect to trussed rafters include:

- Site storage of trussed rafters
- Manual handling of trussed rafters
- Mechanical handling of trussed rafters
- Assembly of trussed rafter roofs

During the assembly stage, several issues are addressed namely the provision of bracing, the use of proper fixings and the cutting of rafters.

Upon advice from the TRA, the latter issue (cutting of rafters) was selected as the Trojan Horse message for this study.

4 DESIGN OF MESSAGES AND MESSAGING MEDIA

The messages were designed to highlight specific safety issues relating to the construction types selected from this study. The philosophy adopted for the design was to produce messages that illustrate bad practice for maximum impact. Examples of such messages are provided on the Safety Alert and Database Exchange Information (SADIE) website and are shown in Figure 2.

Figure 2 Typical messages from SADIE website

SADIE was developed as part of the Step Change in Safety programme initiated by the major offshore operators following the Piper Alpha disaster. The photographs shown in Figure 2 together with summary sheets of lessons learnt from the incidents are disseminated to the employees to reinforce safety awareness.

It was decided to use a similar strategy for the Trojan Horse messages whereby the visual impact would be maximised by illustrating consequences of accidents. However, as discussed in section 4.1, the participating companies did not endorse this approach as generally only good practice is shown on safety related posters to reinforce correct procedures.

Following recommendations from the Steering Group, it was decided that the messages could be enforced through cartoon illustrations, text and photographs. The actual medium depended on the message and the component. However, it was recognised that the medium should not be altered within a product range.

Language and literacy issues were not specifically addressed as these relate to only a small percentage of operatives and fall outside the scope of the project. However, it was assumed that the pictorial representations would achieve a larger audience than purely textual messages.

4.1 STEEL FRAME ERECTION

The issue selected for this construction type related to the slinging of components during erection. The message (used in site trials) is shown in Figure 3 and illustrates the hazard from improper slinging of steel components whereby slippage may occur. Also shown as a caption is the proper way of slinging components with the slings inclined at an angle of approximately 60^0.

However, during the site trials, it was observed that the operatives used a different procedure for slinging of components. The use of chains, instead of slings, was common practice and the slinging procedure involved 'choking' (i.e. double wrapping) the chain around the component.

In addition, the participating companies expressed their concern at the depiction of the crane operator leaning out of the cab and the steel component hitting the operative at ground level.

Following advice from the companies, it was decided to alter the message to reflect actual site practice. The revised design is shown in Figure 4.

Figure 3 Safety message for steel frame erection (used for site trials)

Figure 4 Safety message for steel frame erection

4.2 PROFILED STEEL DECKING

The cartoon illustration shown in Figure 5 was chosen to highlight the hazard arising from improper stacking of loose sheets at heights. Under strong wind conditions, loose sheets can act as missiles that can cause harm and injury to both site operatives and members of the public.

The decking is usually delivered in bundles of up to 24 sheets with the sheets secured with metal banding. Breaking of the bundles and installation can proceed if the sheets can be positioned and secured [12]. However, due to time constraints, it is sometimes not possible to install all the sheets. The partially used bundles must therefore be properly secured to avoid the hazard posed by loose sheets being blown in strong winds.

The message was sent to profiled sheet steel suppliers and fixers for validation in the light of experience with the steel frame erection messages.

However, the manufacturers noted that the safety issue highlighted in the message, although relevant, was not particularly critical as installation of decking is stopped in windy conditions.

The main concern of the manufacturers related to the overloading of the steel decking (prior to concreting) due to careless storage of materials such as bundles of bar reinforcement, skips for debris and heavy machinery. In these cases, the loads should be positioned directly over the support beams and timber spreaders should be used to distribute local loads.

The message was altered to address this issue and is shown in Figure 6.

4.3 PRECAST COMPONENTS

The Trojan Horse message for precast components relates to the stability of the supporting steel structure and is shown in Figure 7.

The key problem areas were seen to be smaller ‘domestic’ sites where the coordination between trades was more difficult. In particular, poorly prepared receiving bearings, particularly masonry, was identified as a problem issue where the site preparedness was not being pre-surveyed by the supplier in a ‘supply only’ contract.

The steel beam shown in the figure is not properly fixed to the padstone and poses a hazard. Prior to installation of the precast component, the supporting structure must be checked to ensure that it is adequately supported and propped. The message also highlighted the proper way of fixing the steel component to the padstone.

4.4 TRUSSED RAFTERS

The cutting of trussed rafters was highlighted as an important safety issue by the TRA and was used as the Trojan Horse messaging for this construction type.

As with Pre-cast flooring units, concerns were expressed regarding coordination in the supply chain. These issues were more likely to arise in supply only contracts. Also, in this case, the vulnerability of components beyond first build was highlighted and the advantages of leaving messages attached were emphasised.

The message is shown in Figure 8 where it is observed that the site operative is cutting the trussed rafter to suit the site dimensions. This will inevitably undermine the load-carrying ability of that particular rafter and may lead to an unsafe structure.

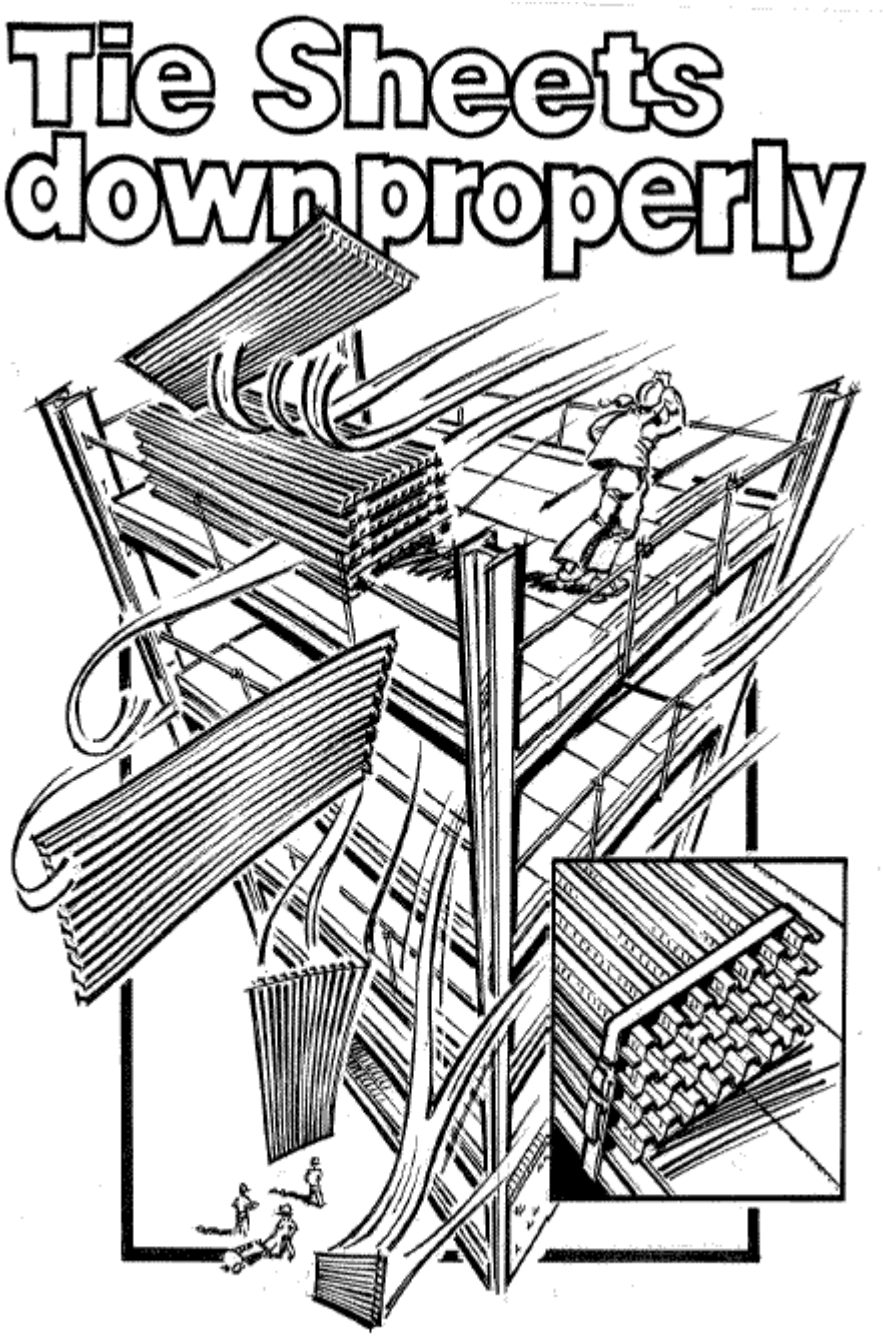

Figure 5 Safety message for profiled steel decking

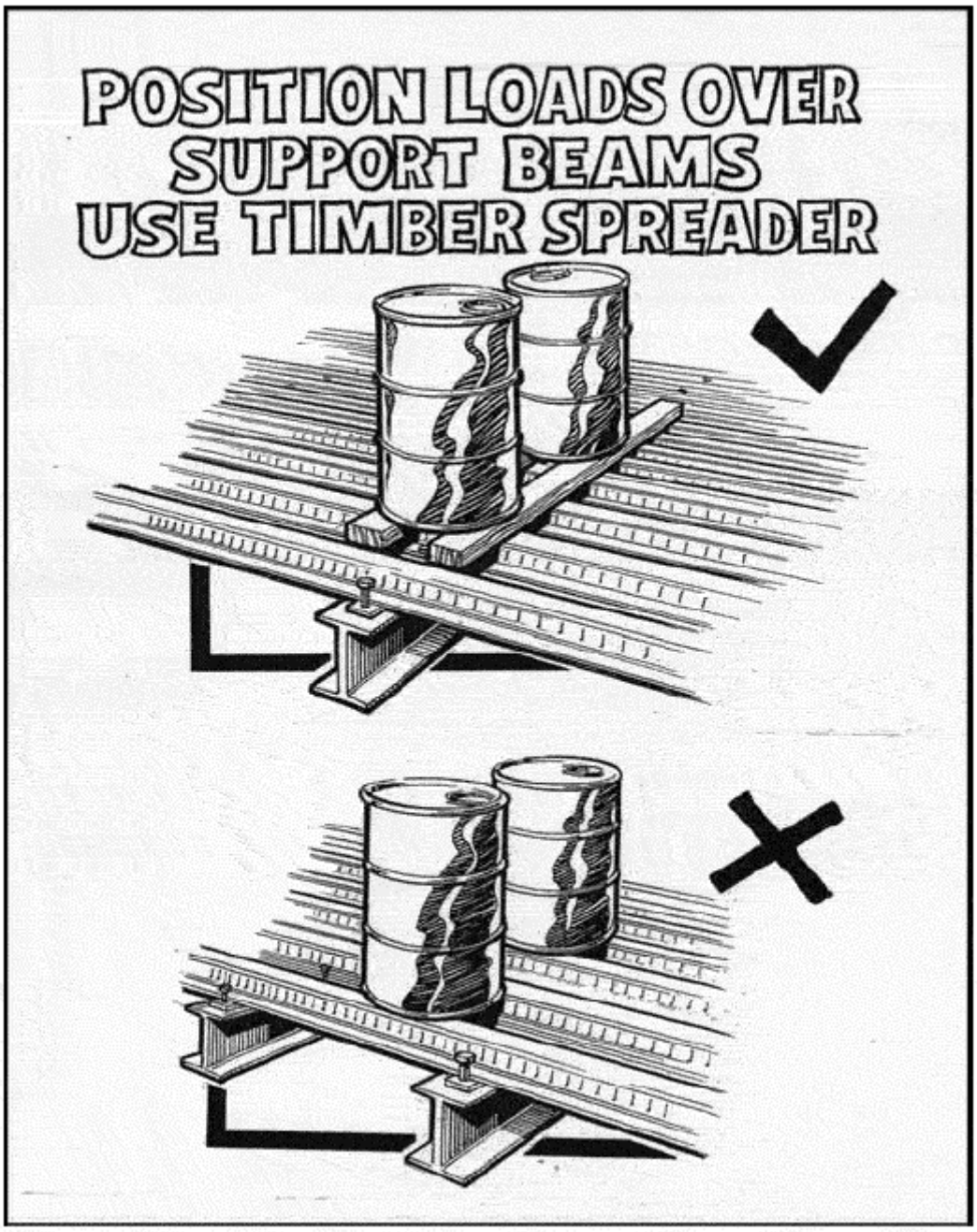

Figure 6 Safety message for profiled steel decking

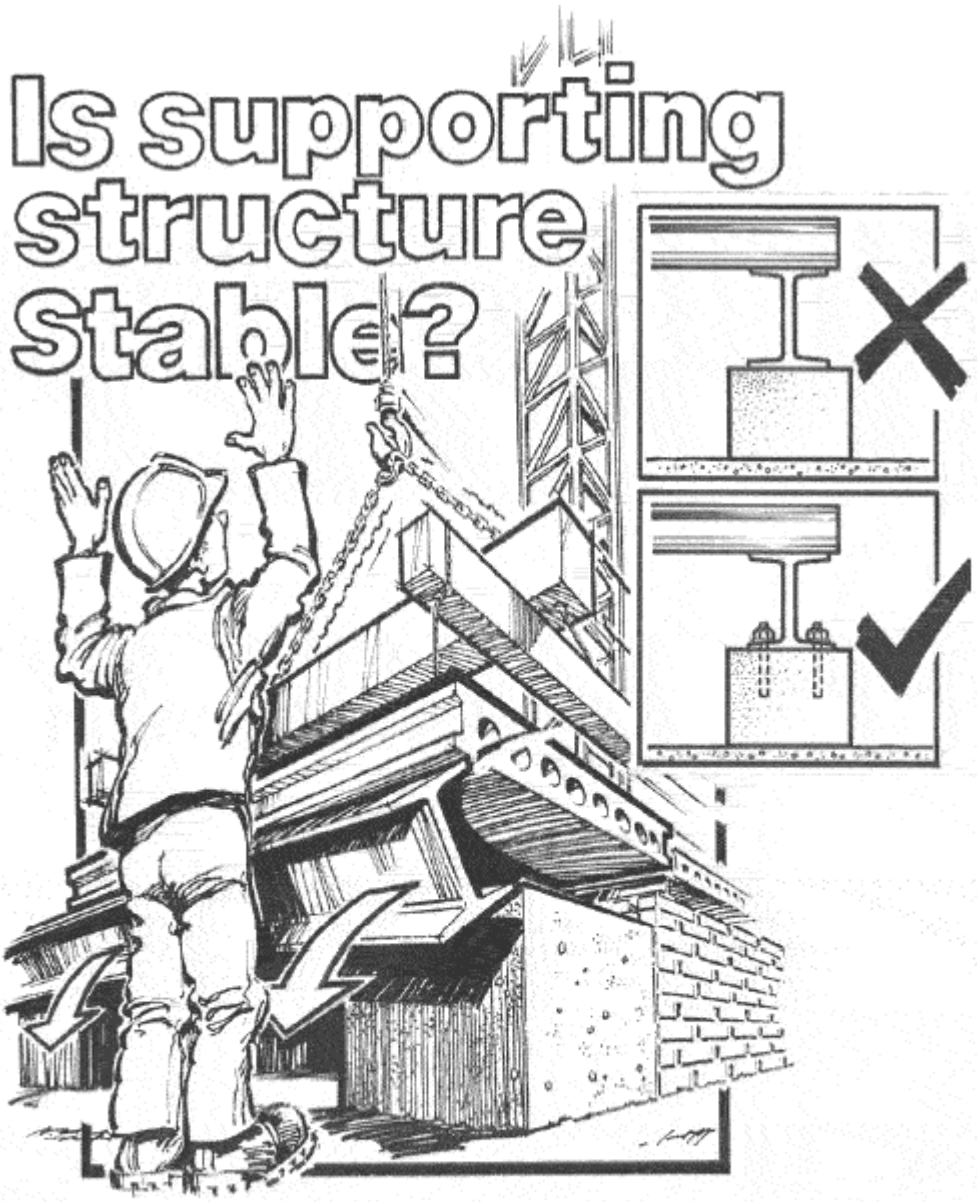

Figure 7 Safety message for precast components

Figure 8 Safety message for trussed rafters

5 PRACTICAL IMPLEMENTATION OF MESSAGES

The practical application of the messaging required a format that is robust and which could be easily applied and removed. It was decided to use a 'sticky back' format that could be easily peeled off and applied to the respective components. It was important to test:

a) Ease of application (and subsequent removal) in the works, including message frequency;

b) Robustness of messages through works and on site;

c) Acceptability of message content;

d) Issues caused by messages on site.

Initially a standard A4 format was selected. It was thought that this was sufficient for visibility and for carrying a reasonably detailed message.

The practical outcomes are further discussed according to the component.

5.1 STEEL FRAME ERECTION

The messages for this construction type, as used during the site trials, were A4 in size and applied to the baseplate of columns.

This format performed well during the site trials and the message (slinging of components) was observed by all the operatives within the gang. In this particular case, the messages were stuck to the base of the column so that there was no need for them to be removed, as they would be covered by the grouting.

The frequency of the messaging was approximately 1 in 10 components and the messages were found to be robust enough to withstand transportation and site handling.

As mentioned in the section 4.1, it was decided to modify the message used for the trials (Figure 3) to reflect industry practice (Figure 4). Furthermore, following advice from the participating companies, it was decided to alter the size of the message to A6 so that they can fit on most sizes of steel components. The format was still 'sticky back' with a similar messaging frequency on the components.

In addition, based on the advice from the participating companies, it was decided to have the message printed in high-visibility colours (yellow/green background) so that they stand out clearly (Figure 9).

It was found during the site surveys that the messages did not stick properly to the painted steel components. Messages with 'stronger' adhesive were ordered from the printers and were found to perform well. However, if removal of the messages prior to installation is required, it is recommended to simply attach the messages to components by strings (or wires) through the boltholes.

A photograph of the messages on the steel components is shown in Figure 10.

Figure 9 Message for steel components

Figure 10 Photograph of message on steel beam

5.2 STEEL DECKING

The messages for the profiled steel decking were applied to both the bundles and drums of shear connectors. Following discussions with the manufacturers, it was decided to have 2 separate formats for the messages.

The messages used on the bundles were approximately A5 in size with a hardback cover designed to fit in a plastic wallet, which was subsequently inserted through the metal banding. 3 wallets containing the messages were used on each bundle and were positioned on the right, middle and left sides of the bundle.

The messages used for the drums were A4 in size and of sticky back format.

5.3 PRECAST COMPONENTS

The messages for the precast components were applied to each individual unit and were A4 in size. As the number of precast components per site is limited (compared to steel components), all the components were messaged.

Following discussions with participating companies, several problem issues were highlighted, namely:

- Robustness of the messages
- Stickiness of the messages

A sample of the message was sent to the manufacturers and was tested to assess both the robustness and ability to stick to the precast concrete units.

It was found that the messages did not stick well to the units. The manufacturers subsequently used their own special adhesive to stick the messages to the units. A photograph of the messages on the precast units is shown in Figure 11.

5.4 TRUSSED RAFTERS

The messages for the trussed rafter components were A4 in size and were applied to the ends of the rafters. As for the precast components, all the components sent to each site were messaged.

Again, following discussions with the participating companies, the issue of robustness of the messages, particularly during bad weather (trussed rafters can be stored on site for several days prior to erection), was raised. This was investigated, and it was found that the messages were robust enough.

Figure 11 Photograph of message on precast units

6 SURVEY DESIGN

The survey design is subject to a separate report [16]. The principal elements of the design are outlined here and described in greater detail in the appended report.

6.1 SURVEY HYPOTHESES

The principal survey hypotheses were against two issues:

a. The level of awareness of the safety messages when brought to site on construction components and

b. The level of information that is imparted using this method.

From these presumptions, the research made two principal Null Hypotheses:

H0: Site operatives are aware of Trojan Horse safety messages

H0: Site operatives gain information from Trojan Horse safety messages

The survey then tested these through the application of a questionnaire with the principal control variable being the level of prior awareness the operatives have of safety issues.

It was well understood that various side issues may be picked up in the questionnaire and the design was such as to permit this without affecting the principal aims.

6.2 POPULATION AND SAMPLING

The population addressed in this work wais the population of specialist operatives involved in the erection of particular components. There were clearly sub-populations but the samples taken on these were too small for meaningful conclusions to be drawn.

The total number of site operatives interviewed during the main site surveys was 62. This was a small sample compared to the total population of specialist operatives (>10,000) but should allow for statistical tests such as the chi-square test and the student t-test to be carried out. This is discussed in Chapter 8.

6.3 DESIGN OF THE QUESTIONNAIRE

The population has particular characteristics that determined the form of questionnaire developed and the manner in which the questionnaire was applied. In the design of the questionnaire the requirements of the HSE's GAP 5 [17] were paramount and the survey questionnaire was designed in accordance with these guidelines.

The principal characteristic and the influence on the questionnaire are tabulated as follows:

Table 3 Characteristics of specialist operatives sample

Characteristic	**Issue**	**Action**
Limited literacy	These workers are likely to be of mixed literacy ability	Questionnaire comprises closed questions with the use of graphical prompts
Expert in narrow field	These workers tend to know their subject well	Face to face application by construction professionals
Small groups travelling from site to site	Liaison with the companies concerned can be 'difficult	Generally directive for gang to give time to surveyors given through organisation of parent company to give a 'de jour' directive to participate (thus avoiding fore-warning)
Driven by productivity rates	Workers not particularly happy if a detail survey interferes with productivity	The survey was designed as a directed survey to cut down 'interference time' and was applied in gang 'down' or 'canteen' time

6.4 INFLUENCE OF THE PILOT SURVEY

Pilot surveys were carried out on 2 messaged sites and 1 control site. The influence of the trial surveys on the survey questionnaire can be summarised as follows:

- The hypotheses were found to be valid for the 3 surveys carried out. In particular, a high level of awareness of the safety messages was noted to the extent that the operatives suggested alternative proper ways of slinging steel components.

- The sample, as expected, ranged between 4 to 5 specialist operatives per site.

- The messages used in the questionnaire were altered to reflect site practices as discussed in the previous chapter.

- Following requests from the manufacturers, it was decided to assess the difference between responses from supply and fix sites (where manufacturer has own team of erectors) and supply sites only (where, in general, main contractor is responsible for the erection of the component). As is discussed in Chapter 8, however, the sample size for supply sites was too small for any statistical tests to be carried out or meaningful conclusions to be drawn.

7 SITE SURVEYS

The site surveys were carried out by trained field engineers from The Concrete Society. To facilitate the survey process, survey tables were sent to all the participating companies who were requested to supply the survey team with the details listed as shown in the sample Table 4. For all the construction types, the participating companies were requested to supply 3 messaged and 2 control sites.

Table 4 Sample table sent to participating companies

Location ID	Type of site	Address	Site manager (contact details)	Site works	Size (tons)	Number of messages	Date 'messaged' components despatched to site	Date 'messaged' components used by operatives
	Messaged							
	Messaged							
	Messaged							
	Control							
	Control							

On receipt of the completed tables, the members of the survey team liased with the site manager to arrange suitable survey dates. It has to be pointed out that the survey team received excellent cooperation from all the parties involved, which greatly facilitated the survey process.

It has to be noted that the sites were chosen at random by the participating companies from their portfolio of ongoing works. The only proviso in the selection of the sites was their geographical location, which was chosen, as far as possible, to limit the amount of travelling incurred by the field engineers.

The site surveys carried out, according to construction type, were as follows:

- Steel components – 3* messaged sites, 2 control sites
- Profiled steel decking – 2 messaged sites, 2 control sites
- Truss rafters – 3 messaged sites, 2 control sites
- Precast units – 2 messaged sites, 2 control sites

* A longitudinal survey was carried out on 1 of the messaged sites (Merthyr Tydfil). This consisted of 3 visits to the site with the interval between each visit spanning approximately 1 month.

The following sections describe the main findings from the surveys carried out. A detailed description of the surveys on each site is provided in Appendix A.

7.1 SUMMARY OF SURVEY FINDINGS

The participating companies were fully involved throughout the process and facilitated the survey by making timely arrangements for the interviews. The main survey findings can be summarised as follows:

- A total of 62 operatives (28 steel component operatives, 14 truss rafter operatives, 9 profiled steel decking operatives and 11 precast unit operatives) were interviewed. The low numbers reflect the specialist nature of the works whereby the components are usually installed by small gangs consisting between 2 to 4 operatives.

- The operatives interviewed during the survey covered a wide experience spectrum ranging from a few months in the UK construction industry to over 36 years of experience.

- Only 7 out of the 62 operatives had no CSCS cards. Most of the other operatives had additional certificates such as the cherry picker licence, CTA slinger certificate, telescopic handler certificate and crane driver's licence.

- It was found that the operatives were generally highly aware of the messages. Only 5 operatives (from a total of 35) on the messaged sites were not aware of the messages.

- Only 2 (out of 27) operatives were aware of new health and safety messages on the control sites although no messages were sent on these sites. On further prompting, it was found that the operatives were referring to their company site erection signs.

- The recall and interpretation of the messages from operatives on the messaged sites was very good. The operatives clearly identified the issues depicted in the messages.

- A similar level of information was imparted to operatives on control sites who were shown the message. Again, the pertinent issues were identified.

- It was noted that the attitude of the operatives during the interview was very positive to the extent that it elicited further comments on the messages. In particular, for the slinging of steel components, several operatives mentioned that the correct way shown on the message is impractical for positioning inclined members. In the latter case, single point slinging with double wrap of the chain is preferred as it allows the member to tilt thereby easing the fixing of the member.

- Several of the steel decking operatives interviewed mentioned the fact that although they are aware of the issue of bad storage of materials, it is usually the operatives from the follow-on trades (e.g. concreting operatives) who are not aware of the problems arising from loading the decking sheets

8 SURVEY ANALYSIS

The main objective of the survey analysis was to validate (or otherwise) through appropriate statistical tests the null hypotheses previously formulated. This was achieved via a re-coding of the survey responses, deriving distributions for the main survey variables namely awareness and information uptake and establishing cross-tabs that were related to the main variables.

The survey analysis procedure adopted in this study is shown in Figure 12.

The following sub-sections provide a brief description of the various steps outlined in the flowchart.

8.1 RECODING OF SURVEY RESPONSES

The questions in the messaged survey questionnaire were split into 3 distinct categories:

1. Questions (1 - 7) that addressed general and specific characteristics of operatives,

2. Questions (8 -10c) that tested awareness of messages, and

3. Questions (10c -13) designed to assess information uptake from messages.

For the control survey questionnaire, a similar logic was adopted with the following differences:

a) Only one question (8) was related to awareness. This was to account for the Hawthorne effect (change in behaviour of employees due to the fact that researchers expressed an interest in them – may lead to operative giving perceived 'correct' answers to please interviewer) and 'background noise' (interference of other messages, posters on site).

b) Only one question (9) was related to information uptake.

In order to carry out statistical tests, the answers (both tick boxes and textual types) needed to be re-coded into a format suitable for analysis. An integer scale was adopted for the questions. The coding of the questions is shown in Table 5.

8.2 SAMPLE V/S GENERAL POPULATION

For the survey analysis to be valid, it needed to be shown that the sample used was representative of the general population. In this particular case, it must be shown that the respondents were representative of the population of specialist operatives.

This could be argued as valid purely from the fact that the selection of manufacturers and sites were based on a random selection and therefore formed a statistically valid random sample.

In addition, it was proposed to compare the experience profile and qualifications of the sample data against population data from the CITB Construction Skills Foresight report [18]. However, the latter data was mostly generic and did not provide breakdown of operatives according to the four construction types investigated in this study.

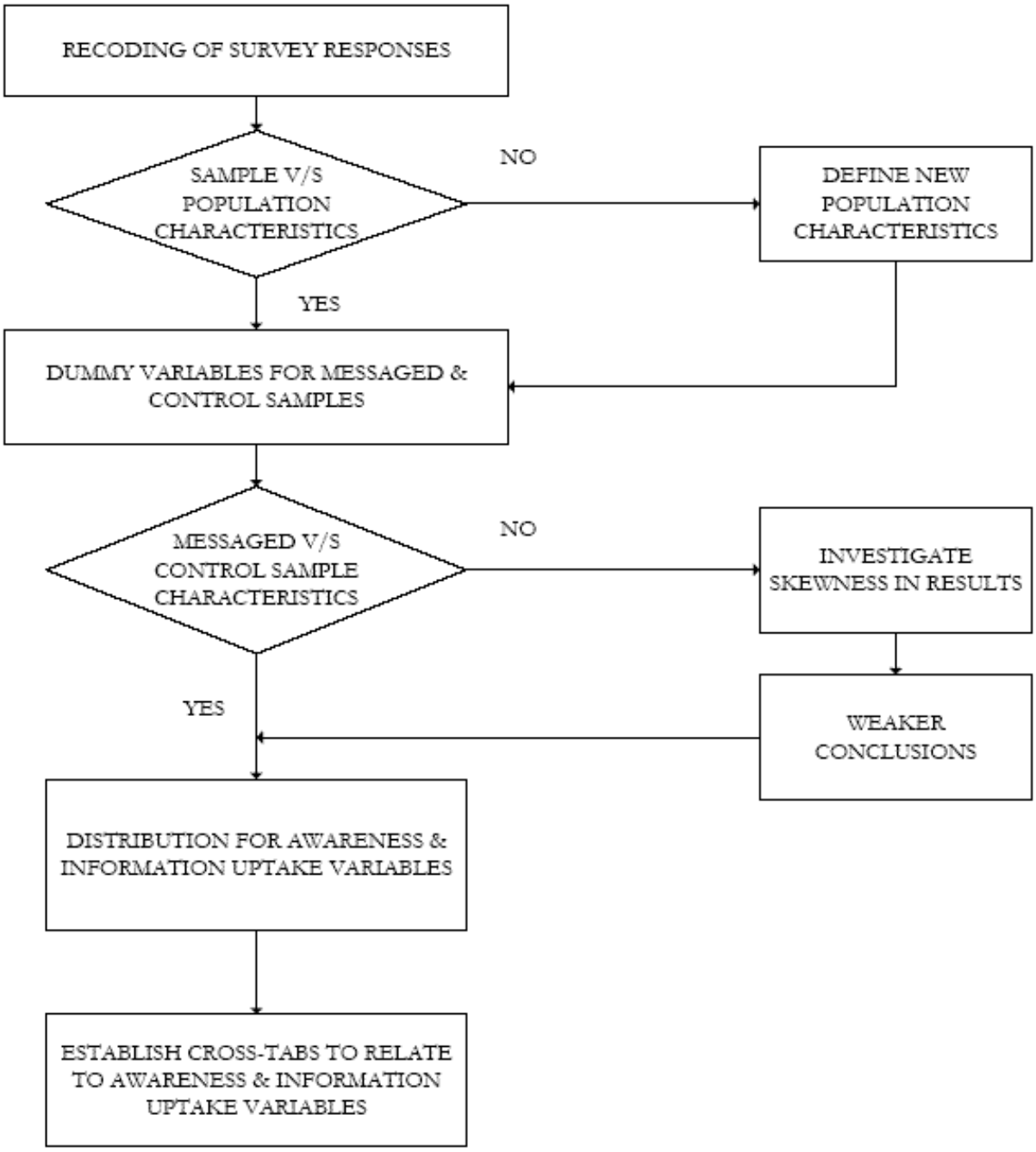

Figure 12 Survey analysis procedure for Trojan Horse messaging

Table 5 Re-coding of questions for survey analysis

Questions	Description	Code Number
General	Control site	0
	Messaged site	1
Question 1	Circled answer	1
	Others	0
Question 2		Actual number of years entered
Question 3	No H&S qualifications	0
	H&S qualifications	1
Question 4		Actual number of weeks entered
Question 5	No H&S induction	0
	H&S induction	1
Question 6	No toolbox talk	0
	Attended toolbox talk	1
Question 6a	Days	1
	1 – 4 weeks	2
	1 – 3 months	3
	> 3 months	4
Question 6b	Did not address H&S issue	0
	Addressed H&S issue	1
Question 7	Not witnessed accidents	0
	Witnessed accidents	1
Question 8	No	0
	Yes	1
	Unsure	2
Question 9	No	0
	Yes	1
Question 10a to 10d	Respondents on message	1
	Partly on message	2
	No idea or unclear	3
Speed of response	Hesitant	0
	Rapid	1
Question 11	No	0
	Yes	1
Question 12	Good interpretation	1
	Average interpretation	2
	Poor or wrong interpretation	3
Speed of response	Hesitant	0
	Rapid	1
Question 13	No additional notes	0
	Additional relevant notes	1
Operatives attitude		Enter circled number

The CITB data quoted that 74% of employees in the construction trades are qualified to at least NVQ level 2. For the sample data, it was found that 88% of the operatives interviewed were qualified i.e. had CSCS cards, CTA slinger certificate, NVQ's etc. It can be deduced that the sample and population share the same qualifications characteristics as the sample data referred to a range of certificates in addition to the NVQ's and hence the higher percentage figure.

Comparison of the experience profile was more problematic as the CITB data referred to the actual age of the operative and included all the construction trades (general and specialist operatives) whereas the sample data was in terms of the specialist operatives' experience in the UK construction industry.

Assuming a benchmark age of 18, the population (CITB) data was modified to enable a comparison with the sample data. The result is illustrated in Figure 13 where it is observed that the sample data exhibits higher percentage of younger operatives than the population data. However, there is a good spread of experience within the sample data.

It is not possible to draw to any definite conclusion from this comparison for the reasons outlined above. However, it is noteworthy to observe the sample data does not exhibit high skewness towards either end of the experience spectrum, which would have indicated a high level of inexperienced or very experienced operatives.

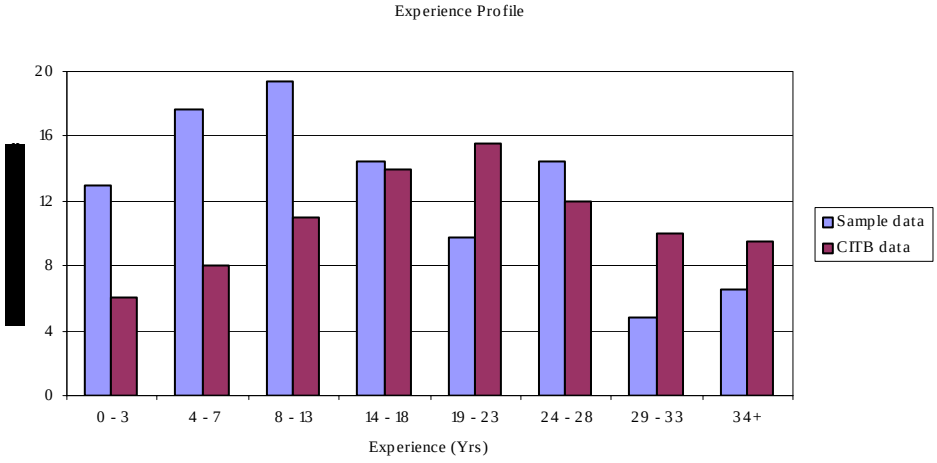

Figure 13 Experience profile distribution of sample v/s population (CITB data)

8.3 MESSAGED V/S CONTROL SAMPLES

In order to derive meaningful conclusions from the survey, it must also be ascertained that both the messaged and control samples shared the same characteristics. Dummy variables relating to the qualifications and experience profile of the operatives were used to assess whether there was any differences between the two samples.

Statistical tests (chi-square and Student t-test) were carried out on both dummy variables and are shown in Appendix B. The results showed that both the messaged and control samples shared the same characteristics as far as those dummy variables were concerned. A comparison of the experience profile of the operatives between the messaged and control samples is also plotted in Figure 14. It is noted that there is good agreement between the data sets.

The results from the statistical tests and the plot imply that the results from the control site can be used to benchmark those from the messaged sites.

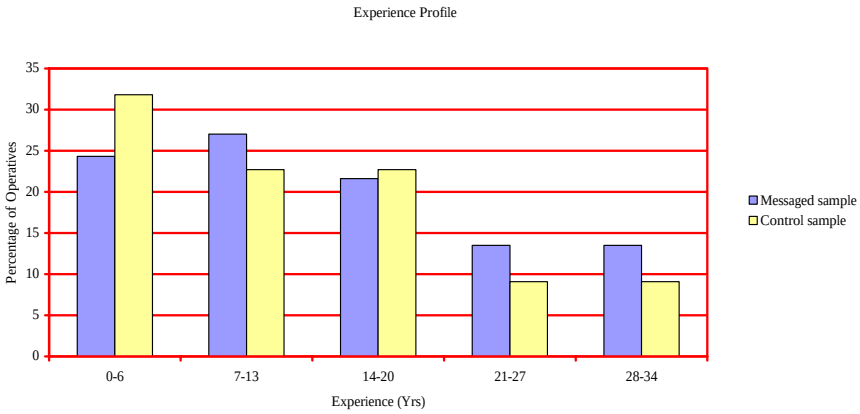

Figure 14 Comparison of experience profile between messaged and control samples

8.4 AWARENESS VARIABLE

The distribution of the awareness variable was obtained via a chi-square test. The results (Appendix B) showed that there was a significant difference between the control and messaged samples at 99% level of confidence. The difference between the samples was expected insofar as no messages were sent on the control sites. However, the difference also showed that the background noise from other messages was minimal.

Generally, there are a number of posters and signs on sites relating to health and safety and the fact that a large proportion of the operatives on the control sites were not aware of any health and safety notices whilst those on messaged sites noticed the Trojan Horse messages imply that the latter technique is a better means of delivering safety information.

In addition, on the messaged sites only, a level of awareness scale was defined based on the amount of prompting of the operative and was as follows:

Highly aware – no prompting: operative is aware of Trojan Horse message when asked about new health and safety messages

Aware – verbal prompting only: operative is aware of Trojan Horse message after interviewer verbally pointed out location of message.

Low Awareness – verbal & visual prompting: operative is aware of Trojan Horse message after interviewer verbally pointed out location of message and showed operative a picture of the message.

No Awareness – operative is not aware of Trojan Horse message even after verbal and visual prompting by interviewer.

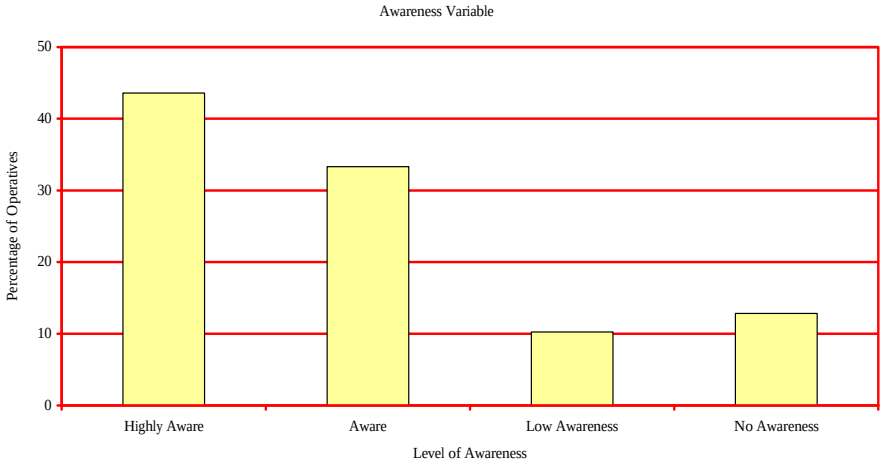

Figure 15 Distribution of awareness variable among operatives on messaged sites

The distribution of the awareness variable among the operatives on messaged sites is shown in Figure 15. It is observed that over 40% of the operatives were highly aware of the Trojan Horse messages, which implies a high uptake of the messages.

Analysis of the site data also showed that several of the operatives on the messaged truss rafter sites did not identify the Trojan Horse message as a health and safety message but rather as a structural message. This is an issue of message content rather than awareness.

8.5 INFORMATION UPTAKE VARIABLE

The information uptake from the messages was tested on both the messaged and control sites by asking the operative to describe the content and meaning of the message.

On the messaged sites, a 3-point scale was adopted to assess the level of information uptake namely high information uptake, low information uptake and no information uptake:

High information uptake - operative recalls the message from memory and provides a good description.

Low information uptake - operative had low or no awareness and was shown the message before providing a good description.

No information uptake - operative was not aware of message and could not provide a good description even when shown the message.

On the control sites, the operative was shown the message before being asked to describe the content and meaning of the message. A 2-point scale was adopted for the control sites namely high information uptake and low information uptake as follows:

High information uptake - operative provides a good description of the message.

Low information uptake - operative could not provide a good description of the message.

The results are shown in Table 6. It is seen that there is a high level of information uptake on both the messaged and control sites. This implies that the Trojan Horse messaging technique is an efficient means of delivering safety information to operatives insofar as it achieves a similar outcome as actually walking up to an operative and showing the message.

Table 6 Distribution of level of information uptake among operatives on both messaged and control sites

	Level of Information Uptake		
	High	Low	No (Messaged sites only)
Messaged Sites	28	7	0
Control Sites	27	0	-

8.6 CROSS-TABS

Cross-tabs were defined to investigate any particular trends in the results. In this case, both the experience and the qualifications of the operatives were used to assess whether those variables influenced the awareness and information uptake.

8.6.1 Experience variable

Table 7 gives the breakdown of the level of awareness of the operatives on messaged sites against their experience.

Table 7 Distribution of level of awareness in terms of experience of operatives (messaged sites only)

Experience (Yrs)	Highly aware	Aware	Low awareness	No awareness
0 - 4	2	1	0	3
5 - 9	5	3	0	0
10 - 14	0	3	0	0
15 - 19	1	1	0	0
20 - 24	6	2	0	0
25 - 29	2	0	1	1
30+	0	2	1	1

There is not sufficient data in each of the cells to carry out any small sample statistical tests. Only observational statements can be made regarding the distribution of the data.

It seems that there is no correlation between the experience of the operatives and their level of awareness of the Trojan Horse messages.

A similar table was drawn up to assess the effect of experience of operatives on messaged sites on their level of information uptake. This is shown in Table 8. Again, due to the sparse data, it was possible to carry out any meaningful statistical tests.

Table 8 Distribution of level of information uptake in terms of experience of operatives on messaged sites

Experience (Yrs)	High Information Uptake	Low Information Uptake	No Information Uptake
0 - 4	3	3	0
5 - 9	8	0	0
10 - 14	3	0	0
15 - 19	2	0	0
20 - 24	8	0	0
25 - 29	2	2	0
30+	2	2	0

There seems to be a weak correlation between experience and level of information uptake with operatives at either end of the experience spectrum exhibiting low information uptake.

8.6.2 Qualifications variable

The effect of the qualifications of the operatives on their level of awareness and information uptake is shown in Table 9 and 10 respectively.

Table 9 Distribution of level of awareness of operatives in terms of their qualifications (messaged sites only)

Qualifications	Highly aware	Aware	Low awareness	No awareness
Qualified	15	9	1	5
Unqualified	1	3	1	0

Table 10 Distribution of level of information uptake of operatives in terms of their qualifications (messaged sites only)

Qualifications	High Information Uptake	Low Information Uptake	No Information Uptake
Qualified	24	6	0
Unqualified	4	1	0

Again, due to the small data set, it was not possible to carry out any meaningful statistical tests. However, some weak conclusions can be drawn as follows:

- There does not seem to be a correlation between qualification and awareness
- Both qualified and unqualified operatives exhibit a similar level of information uptake from the Trojan Horse messages.

8.7 CONCLUSION

The survey analysis has shown that:

- The sample data was representative of the general population of specialist operatives. In addition, the messaged and control sample data were shown to share the same characteristics.

- Over 85% of the operatives on the messaged sites were aware of the Trojan Horse messages – this high percentage of operatives combined with the fact that over 90% of the operatives on control sites did not notice any health and safety messages indicated that the Trojan Horse technique is an effective means to disseminate safety information.

- The information uptake from the messages on both the messaged and control sites was very high. This shows that the Trojan Horse technique achieves a similar outcome as to actually showing an operative the message.

- There seemed to be a weak correlation between the experience of the operatives and their level of information uptake from the Trojan Horse messages. Low information uptake was perceived at either end of the experience spectrum.

- In general, there seemed to be no correlation between experience and level of awareness and also between qualifications and both level of awareness and information uptake. However, larger data sets are required to confirm these observations.

- The longitudinal survey carried out on the site at Merthyr Tydfil showed that the longitudinal impact of the messages did not diminish over time. However, only 2 of the 3 visits targeted the same gang of operatives and, given the small sample size, it is not possible to derive any definite conclusions based on this survey.

9 FEEDBACK FROM INDUSTRY STAKEHOLDERS

Following the positive outcomes from the survey analysis, it was deemed crucial to disseminate the results to the wider industry in order to gain feedback on the potential for large-scale application of the technique.

The following sections provide a summary of the findings from the discussions with the industry stakeholders, which was held at The Institute of Materials, Minerals and Mining on the 24th of September 2004.

9.1 GENERAL COMMENTS

The comments/issues raised regarding the study and application of the Trojan Horse technique in general can be divided into various sub-headings as follows:

9.1.1 Long term effectiveness

There was some concern expressed regarding the long-term effectiveness of the messages. It was recognised that constant exposure to the same messages or even different messages may result in reduced impact of the Trojan Horse technique. Similar work among the manufacturing staff at Hanson plc is currently underway on the longitudinal impact of safety messaging.

Various ways to circumvent the problem were suggested namely:

- Constantly refresh the messages
- Rotate the media/format of the messages and
- Use the messages as part of toolbox talks.

However, it still remains to be shown whether these measures can negate the expected diminishing impact of the messages. Further studies need to be carried out to address this issue.

9.1.2 Message design

It was noted that the messages did not address the ‘Falls from Height’ issues, which is the main area where the bulk of the fatalities occur. The messages were specialist in nature and were targeted at specialist operatives rather than the general low-skill operatives. It was recognised that the project objective was to assess the efficacy of the Trojan Horse method and not the messages.

However, it is essential that any further studies should address ‘Falls from Height’ issues and be targeted at general operatives. This can be achieved by applying messages to general components or materials such as bags of cement or bags of plaster.

In addition, it was also recommended that the messages be extended to address health issues particularly those relating to manual handling, which can lead to musculoskeletal disorders. The latter accounts for two-thirds of all days taken off work in the construction industry and the Trojan Horse messages can be designed to cover these issues.

An example of where the messages can be applied is in the installation of doors and windows where peel-off messages can be easily stuck to the components.

9.1.3 Message application

Various ways of improving the large-scale application of the technique were suggested namely:

- Seasonal blitz whereby the Trojan Horse messages are designed to address seasonal safety issues.

- HSE blitz where the Trojan Horse technique is applied to address critical issue/s identified by the HSE.

It was also mentioned that companies could design their own messages to target issues pertinent to their specific trade and specialist components.

9.1.4 Management of message application

One of the main issues raised during the discussions was the management of the process in particular relating to the liability of various parties.

It was suggested that the trade associations and the Construction Product Association (CPA) be closely involved in the identification of safety issues and in the design of the messages.

Furthermore, it was stressed that it was crucial that the Major Contractors Group (MCG) be kept fully aware and involved in the process to ensure that no conflicting information is sent to site.

9.1.5 Interface issues

Site operatives during interview had indicated that the messages should be directed to those further down the particular construction supply chain, who may abuse certain components inadvertently. This was seen as an interesting use of the messaging technique.

It was noted that the use of messages on timber frame components to convey a message to those interacting with the components at a later date could be easily implemented.

For truss rafters, it was suggested that multiple messaging could be used whereby different messages can be stuck to the components permanently.

9.1.6 Messaging costs

The costs involved in the Trojan Horse messaging technique can be broken down into:

- Cost for design of messages

- Quality assurance costs (design verified and validated by industry)

- Printing costs and

- Distribution costs

- Cost for application of messages

It is not clear whether industry would pick up all of the above costs. The general indication is that component suppliers would be willing to apply the messages to their components but would not pay for the initial production costs.

Certainly, if a level playing field is achieved whereby most of the companies are involved in applying this technique, the associated costs can be significantly reduced to the point where the annual costs are minimal. However, it is at present unclear whether such a situation can be achieved. A survey among the participating companies is currently underway to gauge the level of costs the industry is prepared to bear.

It has been pointed out, however, that even if all members of a trade association are involved in the application of the messaging, this still does not constitute a level playing field. For example, only 70% of all the truss rafter companies are members of the Truss Rafter Association. Application of the Trojan Horse technique by all the member companies may still result in the remaining 30% undercutting their costs.

9.1.7 Uptake of technique

It was suggested that application of the technique would be increased if all industry stakeholders namely the trade associations, the Major Contractors Group (MCG) and the Health and Safety Executive were involved in the process. It was, however, recognised that uptake of the technique would depend mainly on peer group pressure to effect change.

In addition, it was suggested that a website would assist in the uptake of the technique by providing companies with an easy-to-use system for accessing the Trojan Horse messages and literature. The website would offer a range of issues for each construction type whereby providing companies with the means to refresh the messages sent to site.

It was suggested that the website be run by the Health and Safety Executive in conjunction with the trade associations.

9.2 OUTCOME OF DISCUSSIONS

The feedback from the industry stakeholders was positive and the main outcomes from the discussions were as follows:

- A study needs to be carried out to assess the long-term effectiveness of the messages. This study would provide the necessary platform for the subsequent large-scale application of the Trojan Horse technique. It is envisaged to work closely with the trade associations and the Major Contractors Group (MCG) for this second phase of the Trojan Horse study.

- The messages should be extended to target general operatives and to address health issues particularly those relating to musculoskeletal disorders. Ways of delivering the messages on various components have to be investigated. This would be an integral part of the second phase of the Trojan Horse study. Implementation of general messages would require close coordination with MCG members to ensure application of the messages to ‘temporary’ materials (e.g. bags of cement) and to facilitate access to general site operatives.

- It is crucial to determine how the cost for design and production of the messages will be borne. This has to be investigated further and would involve discussions with trade associations, the Health and Safety Executive and the MCG.

9.3 BUSINESS MODEL

The cost of carrying messages onto site comprises of the following costs

- Design of messages

- Quality assurance of messages
- Production and distribution of messages and
- Application of messages

In the research phase, all but the cost of application was borne by the project. However, significant contribution was provided by participating companies in their engagement with message design (Section **Error! Reference source not found.**) and their input into the design of the methods used to deliver messages onto site (Section **Error! Reference source not found.**). A post project survey of participating companies suggests that they are willing to apply messages as long as they are made available to them in a properly quality assured fashion.

The challenge now involves the transfer of costs to industry. The phases in completing a pan-Industry rollout are expected to be as follows:

1. Prime an initial scheme to engage around 100 companies, ensuring that these include industry 'movers and shakers'.
2. Build an advertising-revenue cost support model on the success of an initial rollout.
3. As the uptake of the messaging grows, support the scheme either through levy or continue to support through advertising income.

9.3.1 Costs

It is assumed in this costing that the initial rollout is to engage about 100 companies in the scheme. A broad outline of cost is presented in Table 11below:

Table 11 Costs of Trojan Horse messaging

Cost Element	Unit Cost (£k)	Cost (£k)
Design and QA of messages (1)	2.0	40.0
Production (2)	0.8	80.0
Distribution (3)	40k (fixed) 0.1	50.0
Application	0	0
Total	170k (120k without set-up cost)	

Notes:

1. From project costs, it is estimated that the cost of a single message design is likely to be of the order of £2000. The key factor is that, after deciding upon which health and safety issue to address, the message prototype has to be approved by a number of stakeholders as indicated below. It is estimated that an annual library of some 20 messages would be appropriate.
2. This figure is based on supplying a medium sized fabricator with messages. The fabricator will generate approximately 10,000 tonnes of fabricated components; some

20,000 pieces and at an application rate of one in ten, some 2000 message sheets. Each sheet, including fixing materials, and produced in volume costs about £0.40. The production costs for 100 companies taking this number is indicated

3. It is envisaged that an automated selection and distribution system is set up whereby users order messages in batch online and the messages are distributed directly from printers. The fixed element of cost is to set up a system. This should properly be distributed over time. The cost of distributing a number of packets of varied messages to the volume suggested in (2) is £0.1k.

The recurring costs are therefore of the order of £120k. The design and Q.A. cost element is high, as the library of 20 messages would support a greater working company population. The overall production and distribution costs would be reduced through greater throughput volume.

9.3.2 The use of Advertising

For a self-sustaining future, costs for Trojan Horse message production and distribution need to be found. One model for this is suggested by the business models sustaining Year Books for a number of the Co-Construct partners.

In this model the production and distribution of an Annual Year Book is entirely supported through advertising sales. The advertising sales exist because marketing departments know that the Year Book will arrive on the desk of a number of specifiers for construction products.

By way of analogue, if the Trojan Horse massages were available for easy on-line order, but the messages arrived at the recipient companies with outer packaging carrying advertising relevant to the purchasing of the recipient company, then a second 'Trojan Horse' method is effectively being used to support the health and safety messaging.

This prospect has been discussed in some detail with one of the U.K.' leading print marketing sales companies[1]. We believe that the model is viable and could support one of two outcomes:

- The uptake of the messaging grows (access to messages is free and well supported and companies find that it becomes a competitive necessity). The scheme income grows with the numbers of users.

- The scheme grows, supported initially by marketing sales to a point where messaging is 'de rigour' and seen as a competitive necessity. At this point, marketing is dropped and companies pay a small levy (which is acceptable because the base costs being supported are low).

A marketing income of approximately £250k is currently returned from a single member-based organisation Year Book. Clearly marketing budgets are not infinitely elastic but it is considered viable to generate this sort of income from a scheme with a reasonably wide uptake. This proposals needs to be market tested.

[1] McMillan Scott plc.

10 CONCLUSIONS AND RECOMMENDATIONS

The Trojan Horse project has yielded successful outcomes to the extent that large-scale application of the technique can be envisaged. The main conclusions from the study are as follows:

- The messages were easily applied to a range of components with minimal interference to both site and manufacturing works.

- Site operatives were generally highly aware of the Trojan Horse messages. The results also indicated that other site messages had minimal impact on the awareness of the operatives.

- The recall and interpretation of the messages by the operatives was very good. This implies that the Trojan Horse messaging results in levels of information uptake similar to that achieved by actually showing an operative the message.

Following discussions with the Steering Group and the industry stakeholders, it was recommended that a second phase of the Trojan Horse study be carried out with the following objectives:

- Assess in more detail the longitudinal impact of the messaging technique. Similar work is currently underway at Hanson plc and it may be possible to link up the studies to investigate the long-term effectiveness of the messages.

- Address general 'Falls from Height' issues to target both general and specialist operatives. This can be achieved by printing messages on packaging used for temporary materials and can be incorporated as part of the longitudinal study.

- Extend the messages to cover health issues particularly those relating to musculoskeletal disorders.

Furthermore, it is proposed that as part of the second phase, a business model for large-scale application of the technique could be developed. The model will investigate several ways for securing funds for the production and distribution of the messages based upon advertising sponsorship. This method of funding has already been successfully applied by The Steel Construction Institute in various projects.

It is expected that a second phase for the Trojan Horse study would involve active participation from all the industry stakeholders (trade associations and their member companies, Major Contractors Group and Health & Safety Executive). This would not only ensure valuable feedback from the wider industry but also assist in the subsequent large-scale uptake of the technique.

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APPENDIX A

A.1 STEEL COMPONENTS

Table A.1 shows the site surveys carried out for the steel components construction type.

Table A.1 *Site surveys for steel components*

Site	Type	Status	Number of operatives
Telford	Messaged	Completed	5
Chippenham	Messaged	Completed	5
Merthyr Tydfil	Messaged	Completed (3 site visits)	4, 4, 4
Swansea	Control	Completed	3
Enfield	Control	Completed	3

It is noted that the site in Merthyr was used as a longitudinal site i.e. 3 site visits were carried out. The following sub-sections provide a brief description of the results on the sites surveyed.

A.1.2 Telford site

- A total of 5 operatives were interviewed on this site. This was a medium-sized site with a total tonnage of approximately 650 tons of steel. The operatives had been working on this site for approximately 3 weeks.

- The operatives interviewed on this site had between 3 to 6 years of experience in the construction industry in the UK. All the operatives had CSCS cards.

- All the operatives on this site were aware of the Trojan Horse messages.

- The interpretation of the message was good in all 5 cases with the operatives recognising the right way to sling steel components. 2 of them pointed out that there are additional correct ways for slinging steel.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.1.3 Chippenham site

- 5 operatives were interviewed on this site. This was a medium-sized site with a total tonnage of approximately 250 tons of steel. The operatives had been working on this site for approximately 2 weeks.

- The operatives on this site had between 8 and 28 years of experience in the construction industry in the UK. All the operatives had CSCS cards in addition to other certificates such as CTA slinger certificate, cherry picker licence, crane licence, telescopic handler and forklift licence.

- All the operatives on this site were aware of the Trojan Horse messages.

- Interpretation of the messages was generally very good with the operatives acknowledging the correct way of slinging steel components. 3 of the operatives mentioned that the correct

way shown on the message is impractical for positioning inclined members. In the latter case, single point slinging with double wrap of the chain is preferred as it allows the member to tilt thereby easing the fixing of the member.

- The operatives' attitude was positive during the interview.

A.1.4 Merthyr Tydfil site

- 3 visits were carried out on this site to assess the long-term impact of the messages

- It was intended to target the same gang of operatives for the 3 visits. However, given site practicalities, it was only possible to interview the same gang for the last 2 visits.

- 4 operatives were interviewed during the first visit. The operatives had between 6 months to 34 years of experience in the construction industry in the UK. They all had CSCS cards in addition to CTA slinger certificate, CITB and CPCS certificates.

- 4 operatives were interviewed during the second and the third visits. The operatives had between 12 to 28 years of experience in the construction industry in the UK. They all had CSCS cards in addition to crane licence, CTA slinger certificate and NVQ.

- All of the 4 operatives during the first visit were aware of the messages. For the second and third visits, 3 of the 4 operatives were aware of the messages while one of them did not notice any of the messages on the steel components.

- The message interpretation by the operatives was good for all the 3 visits carried out. They correctly identified the correct way for slinging steel components as being the issue.

- The operatives' attitude was positive during the interviews.

A.1.5 Swansea site

- 3 operatives were interviewed on this site. This was a medium-sized site with a total tonnage of approximately 120 tons of steel. The operatives had been working on this site for approximately 1 week.

- The operatives on this site had between 4 and 25 years of experience in the construction industry in the UK. All the operatives had CSCS cards in addition to other certificates such as CTA slinger certificate, cherry picker licence, crane licence, telescopic handler and forklift licence.

- No messages were sent to this site. However, 2 of the operatives said they were aware of new health and safety messages. On further probing, the messages the operatives saw relating to the company's safety erection signs.

- When shown the message, the operatives' interpretation of the messages was generally very good.

- The operatives' attitude was positive during the interview.

A.1.6 Enfield site

- 3 operatives were interviewed on this site. This was a medium-sized site with a total tonnage of approximately 220 tons of steel for 3 portal frame units. The operatives had been working on this site for approximately 2 weeks.

- The operatives on this site had between 1.5 and 15 years of experience in the construction industry in the UK. All the operatives had CSCS cards in addition to other certificates such as CTA slinger certificate, cherry picker licence, crane licence, telescopic handler and forklift licence.

- No messages were sent to this site and none of the operatives noticed any new health and safety messages.

- When shown the message, the operatives' interpretation of the messages was generally very good.

- The operatives' attitude was positive during the interview.

A.2 PROFILED STEEL DECKING

The site surveys carried out for the profiled steel decking are shown in Table 7.3.

Table A.1 *Site surveys for profiled steel decking components*

Site	Type	Status	Number of operatives
Northolt	Messaged	Completed	2
Exeter	Messaged	Completed	2
Bridgend	Control	Completed	3
Wednesbury	Control	Completed	2

Generally, only 2 specialist operatives work on the installation of the decking sheets. This resulted in slightly lower numbers than expected for our sample but is a reflection of the specialist nature of the works.

A.2.2 Northolt site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for approximately 1 week.

- The operatives interviewed on this site had 4 and 14 years of experience in the construction industry in the UK. Both operatives had CSCS cards.

- None of the operatives were aware of any new health and safety messages. Even after being shown the message for profiled steel decking, they had no awareness of the message. It was found that no messages were sent to this particular site. As such, this site was treated as a control site subsequently.

- When shown the message, the operatives' interpretation was good in both cases with the operatives recognising the right way to support loads on decking sheets.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.2.3 Exeter site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for 1 day.

- The operatives interviewed on this site had 4 and 8 years of experience in the construction industry in the UK. Both operatives had CSCS cards.

- None of the operatives were aware of any new health and safety messages. Even after being shown the message for profiled steel decking, they had no awareness of the message. It was found that no messages were sent to this particular site. As such, this site was treated as a control site subsequently.

- When shown the message, the operatives' interpretation was good in both cases with the operatives recognising the right way support to loads on decking sheets.

- The operatives also pointed out that the problem lies with the follow-on trades not being aware of the loading issues depicted in the message. In particular, the concreting operatives would lay their stack of reinforcing bars randomly on the decking sheets and has resulted in damage to the sheets in several cases.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.2.4 Bridgend site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for approximately 1 week.

- The operatives interviewed on this site had 6 and 10 years of experience in the construction industry in the UK. Both operatives had CSCS cards.

- No messages were sent to this site and none of the operatives noticed any new health and safety messages.

- When shown the message, the operatives' interpretation was good in both cases with the operatives recognising the right way to support loads on decking sheets.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.2.5 Wednesbury site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for 3 days.

- The operatives interviewed on this site had 8 and 14 years of experience in the construction industry in the UK. Both operatives had CSCS cards.

- No messages were sent to this site and none of the operatives noticed any new health and safety messages.

- When shown the message, the operatives' interpretation was good in both cases with the operatives recognising the right way to support loads on decking sheets.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.3 TRUSS RAFTER

The site surveys for the truss rafters are shown in Table 7.4.

Table A.1 *Site surveys for truss rafters*

Site	Type	Status	Number of operatives
Palmers Green	Messaged	Completed	2
Surbiton	Messaged	Completed	4
Tadworth	Control	Completed	2
Chessington	Control	Completed	2
Grove Park	Control	Completed	4

A.3.2 Palmers Green site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for 2 days.
- The operatives interviewed on this site had 1 to 8 years of experience in the construction industry in the UK. Both operatives had CSCS cards.
- All the operatives were aware of the message. It was pointed out, however, that the message was more structural than safety related.
- The interpretation of the message was good in both cases with the operatives recognising that cutting of the rafters will affect the structural integrity.
- Additional issues were raised be the operatives namely the fact that the ladder was not properly secured.
- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.3.3 Surbiton site

- A total of 4 operatives were interviewed on this site. The operatives had been working on this site for periods varying between 1 week to 2 months.
- The operatives interviewed on this site had between 7 to 20 years of experience in the construction industry in the UK. 3 of the operatives had no CSCS cards.
- All the operatives were aware of the message.
- The interpretation of the message was good in all 4 cases with the operatives recognising that cutting of the rafters will affect the structural integrity.
- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.3.4 Tadworth site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for 2 days.

- The operatives interviewed on this site had 22 and 24 years of experience in the construction industry in the UK. Both operatives had CSCS cards.

- All the operatives were aware of the message.

- The interpretation of the message was good in both cases with the operatives recognising that cutting of the rafters will affect the structural integrity.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.3.5 Chessington site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for 1 day.

- The operatives interviewed on this site had 16 and 20 years of experience in the construction industry in the UK. None of the operatives had CSCS cards.

- No messages were sent to this site and none of the operatives noticed any new health and safety messages.

- When shown the message, the operatives' interpretation was good in both cases with the operatives recognising that cutting of the rafters will affect the structural integrity.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.3.6 Grove Park site

- A total of 4 operatives were interviewed on this site. The operatives had been working on this site for approximately 1 week.

- The operatives interviewed on this site had between 5 to 25 years of experience in the construction industry in the UK. All of the operatives had CSCS cards.

- No messages were sent to this site and none of the operatives noticed any new health and safety messages.

- When shown the message, the operatives' interpretation was good in both cases with the operatives recognising that cutting of the rafters will affect the structural integrity.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.4 PRECAST UNITS

The site surveys carried out for the precast units are shown in Table 7.5.

Table 12 Sites for precast units

Site	Type	Status	Number of operatives
Sunderland	Messaged	Completed	3
Bloxwich	Messaged	Completed	2
York	Control	Completed	3
Woodley	Control	Completed	3

A.4.1 Sunderland site

- A total of 3 operatives were interviewed on this site. The operatives had been working on this site for 2 days.
- The operatives interviewed on this site had 1 to 30 years of experience in the construction industry in the UK. All operatives had CSCS cards.
- 2 of the operatives were not aware of any new health and safety messages even after being shown the actual message.
- The recall and interpretation of the message was good for the operative who was aware of the message. In the other 2 cases, the interpretation was also good after being shown the message.
- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.4.2 Bloxwich site

- A total of 2 operatives were interviewed on this site. The operatives had been working on this site for 24 weeks.
- The operatives interviewed on this site had 35 and 36 years of experience in the construction industry in the UK. None of the operatives had CSCS cards.
- Both operatives were aware of the message.
- The recall and interpretation of the message was good in both cases with the operatives recognising that it should be ascertained that the bearings are safe before placing the precast units.
- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.4.3 York site

- A total of 3 operatives were interviewed on this site. The operatives had been working on this site for 1 day.
- The operatives interviewed on this site had 15 to 35 years of experience in the construction industry in the UK. All operatives had CSCS cards.

- No messages were sent to this site and none of the operatives noticed any new health and safety messages.

- When shown the message, the operatives' interpretation was good in all 3 cases with the operatives recognising that that it should be ascertained that the bearings are safe before placing the precast units.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

A.4.4 Woodley site

- A total of 3 operatives were interviewed on this site. The operatives had been working on this site for 1 day.

- The operatives interviewed on this site had 6 months to 30 years of experience in the construction industry in the UK. All operatives had CSCS cards.

- No messages were sent to this site and none of the operatives noticed any new health and safety messages.

- When shown the message, the operatives' interpretation was good in all 3 cases with the operatives recognising that that it should be ascertained that the bearings are safe before placing the precast units.

- The operatives' attitude was positive during the interview. The answers they gave were clear and rapid in all cases.

APPENDIX B SURVEY ANALYSIS

B.1 NOTE ON CHI-SQUARE AND STUDENT T-TEST

B.1.1 Chi-Square test

The chi square test is used to test a distribution observed in the field against another distribution determined by a null hypothesis. Being a statistical test, chi square can be expressed as a formula. When written in mathematical notation the formula looks like this :

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

where O = the frequencies observed and E = the frequencies expected.

When using the chi square test, the researcher needs a clear idea of what is being investigating. It is customary to define the object of the research by writing a hypothesis. Chi square is then used to either prove or disprove the hypothesis.

There are two steps to performing the test:

1. Calculating the chi-squared value from the test result figures using a standard formula.

2. Comparing the chi-squared value with a scale of values given by a standard probability table to produce a probability value.

B.1.2 Student t-test

'Student's' t Test is one of the most commonly used techniques for testing a hypothesis on the basis of a difference between sample means. Explained in layman's terms, the t test determines a probability that two populations are the same with respect to the variable tested.

For the t test for independent samples, it is not required to have the same number of data points in each group. It is assumed that the population follows a normal distribution (small samples have more scatter and follow what is called a t distribution). Corrections can be made for groups that do not show a normal distribution (skewed samples, for example - note that the word 'skew' has a specific statistical meaning). The t test can be performed knowing just the means, standard deviation, and number of data points.

B.2 OPERATIVES DATA

Number of operatives on messaged sites:	35
Number of operatives on control sites:	27
Total number of operatives:	62

B.3 MESSAGED V/S CONTROL SAMPLE TESTS

B.3.1 Qualifications – Chi-square test

	Qualifications		
	Qualified	Unqualified	Total
Messaged	30	5	35
Control	25	2	27
Total	55	7	62

Degrees of freedom = 1

Chi-square = 0.72

For significance at the .05 level, chi-square should be greater than or equal to 3.84.

The distribution is not significant

p is less than or equal to 1.

B.3.2 Experience – Student t-test

Messaged sample: Number of items = 35

0.1, 0.5, 1, 3, 3, 4, 5, 6, 7, 7, 7, 8, 8, 8, 11, 12, 12, 15, 17, 20, 20, 20, 20, 22, 24, 24, 24, 25, 28, 28, 28, 30, 34, 35, 36

Mean = 15.8

95% confidence interval for mean: 12.33 thru 19.25

Standard deviation = 10.8

Hi = 36.0 Low = 0.1 Median = 15

Average absolute deviation from median = 9.5

Control sample: Number of items = 27

0.5, 1.5, 2, 4, 4, 5, 6, 6, 8, 8, 8, 8, 10, 10, 14, 14, 14, 15, 15, 15, 16, 20, 25, 25, 30, 30, 35 Mean = 12.9

95% confidence interval for mean: 8.99 thru 16.86

Standard deviation = 9.35

Hi = 35 Low = 0.5

Median = 10

Average absolute deviation from median = 7.3

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t = 1.09

sdev = 10.2

Degrees of freedom = 60

The probability of this result assuming the null hypothesis is 0.279.

B.4 AWARENESS VARIABLE

Messaged sites		*Control sites*	
Highly Aware:	16 operatives	Aware:	2 operatives
Aware:	12 operatives	Not Aware:	25 operatives
Moderately Aware:	2 operatives		
Not Aware:	5 operatives		

B.4.1 Chi-square test

	Awareness Variable		
	Aware	Not Aware	Total
Messaged	30	5	35
Control	2	25	27
Total	32	30	62

Degrees of Freedom: 1
Chi-square = 37.42
p is less than or equal to 0.001
The distribution is significant.

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