Development of an interactive toolkit for Safe Site as part of the workplace transport priority programme

Prepared by **AIMS Solutions Ltd** for the
Health and Safety Executive 2005

RESEARCH REPORT 361

Development of an interactive toolkit for Safe Site as part of the workplace transport priority programme

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Safe Site is a web delivered software application that makes use of 'virtual reality' and other interactive media elements to educate users on industrial sites safety, particularly where vehicles come into close proximity with other vehicles and pedestrians.

This report is an amalgam of the interim reports and therefore gives a chronological breakdown of the project's development. Stages one and two are more detailed than three and four, as the design effort was focused towards the beginning of the project. The latter stages focused on media production, testing, feedback and system integration.

The report concludes with a series of short recommendations should this project be developed further.

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.

HSE BOOKS

First published 2005

ISBN 0 7176 6134 2

1 Introduction

1.1.1 Safe Site is a web delivered software application that makes use of 'virtual reality' and other interactive media elements to educate users on industrial sites safety, particularly where vehicles come into close proximity with other vehicles and pedestrians.

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1.1.3 The report concludes with a series of short recommendations should this project be developed further.

2 Stage 1

2.1 Interface Design

2.1.1 Based on early discussions, a list of interface requirements was established.

These included:
a) Accessibility, clarity & uniformity
b) Interactivity and logic flow
c) Contextual information
d) Flexibility and extendibility

It was decided that initial interface layouts would be produced as static images only. This allowed the rapid production of and easy reference to previous alternative versions.

2.2 Workflow

2.2.1 Initially it was envisaged that the user would choose the problem they might encounter on their site, and then choose 'objects' which might solve this problem. They could then interrogate these objects to get more information.

2.2.2 A step-by-step or 'wizard' approach to the problem and its solution was introduced. Later a road layout metaphor was tried, where the user would mentally 'drive' around the interface to find the right solution to the problem he/she had chosen from the menu.

2.2.3 A scenario-based approach was set upon, to encourage the user to focus on the cause of the dangerous situation and its potential remediation, rather than on objects and equipment. A change from 'scenarios' to 'case studies based on real events' is undertaken. The emphasis is changed from: a) different views of an unfolding set of remedial actions, to b): a simpler before and after state ('unsafe site', 'safe site').

There are two mechanisms of viewing how sites are made safe:

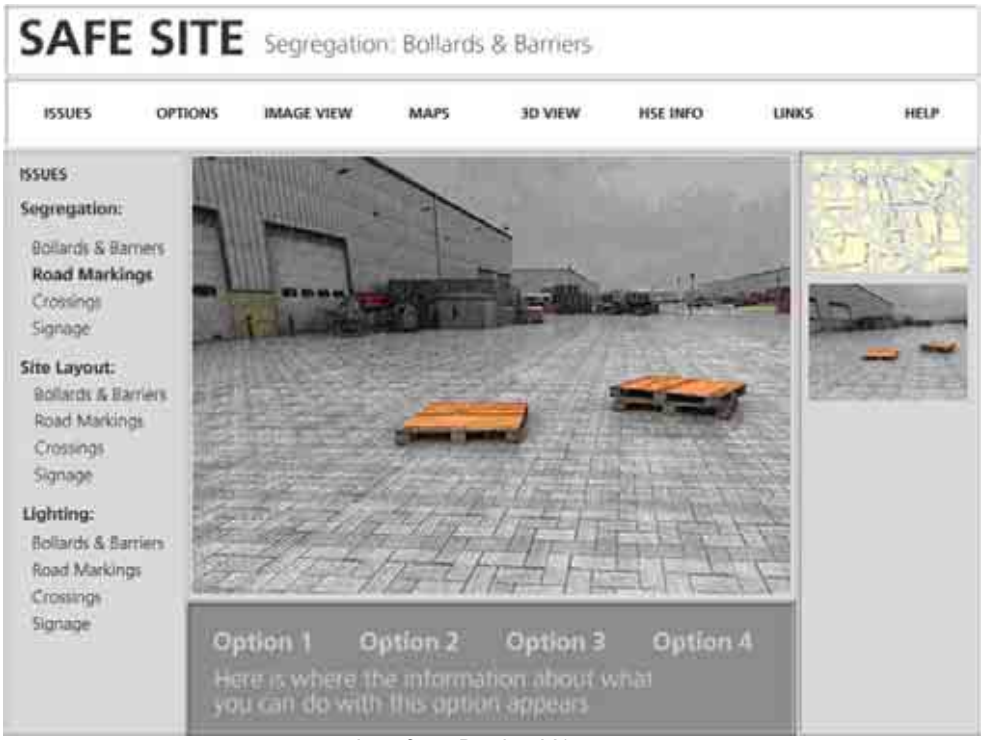
a) *Different* measures applied to *one* site.

b) *One type of* measure applied to a *series* of sites.

2.3 Layout & Navigation

2.3.1 A tab panel with large and small media windows was established, the larger to give an overview of the issues, and the smaller to allow focused investigation of objects or details.

2.3.2 Information panels display any additional information (images and text). The user relates all the information on screen with the single issue (i.e. context sensitive information) through the use of visually separate coloured panels.

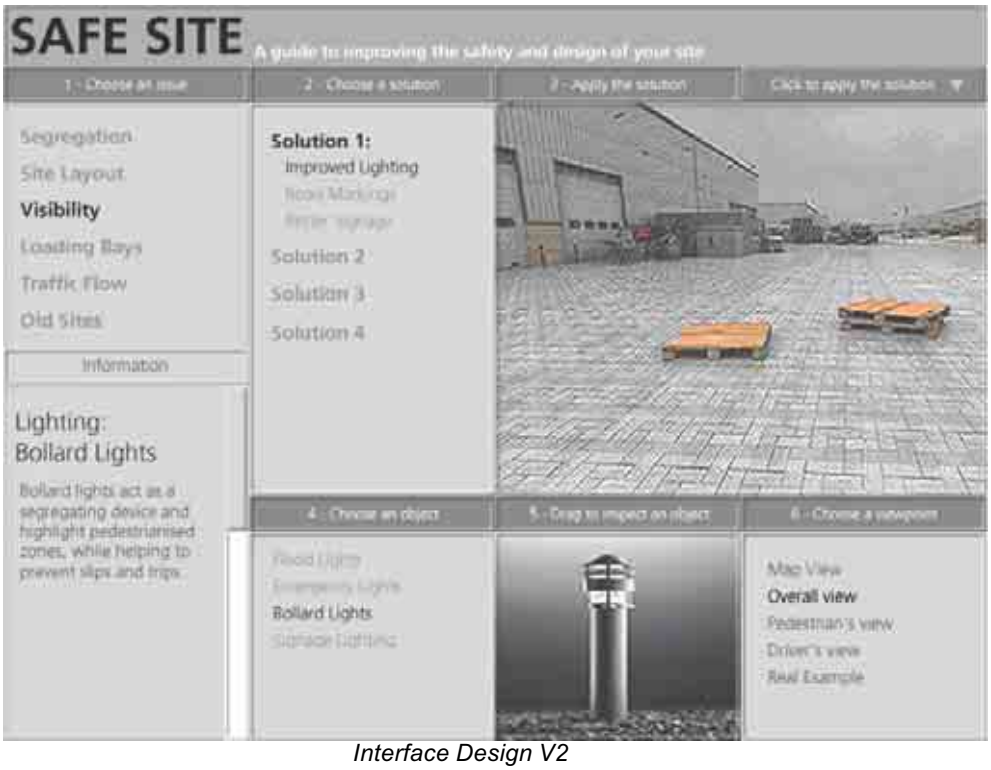


Interface Design V1

2.3.3 The use of a tree menu structure appeared fairly early on and persisted for some time. A great amount of information could be accessed at any time throughout the problem/solution interrogation process. Multiple view buttons were used to change the viewpoint. However, a failing of this approach was that the user had to:

a) Choose an issue
b) Choose a view
c) Apply the solution
d) Interrogate the solution

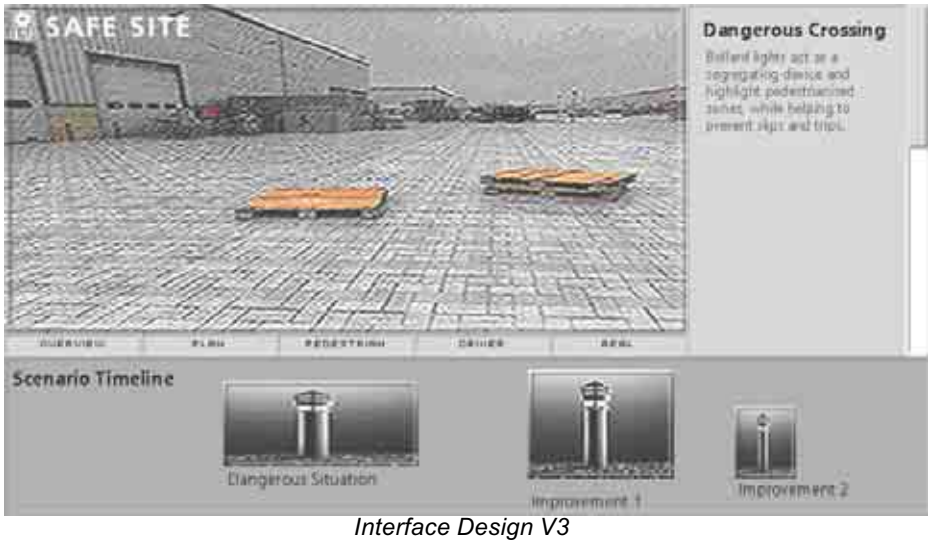
Each of these being in different menu systems caused potential confusion.



Interface Design V2

2.3.4 In answer to this, the tree menu was changed to a scenario & view selection tool. The steps taken to implement the change are accessible from a 'timeline' menu at the bottom of the screen. This left to right timeline, suggests a development or unfolding sequence of events. Thumbnails with links to images and text allow the user to follow the unfolding solution to the dangerous situation described at the start of the scenario.

2.3.5 To simplify the scenario sequence still more, the tree structure was removed and placed in a layer above. Therefore we have a menu page that describes the scenario, and a link to launch the scenario viewer. Here the user can interrogate the unfolding events. They can then change their view and repeat the process by using the reintroduced view menu.



Interface Design V3

2.3.6 The interface now presents a case study viewed before and after remedial measures are taken. A map is now always visible, and acts as a navigational device as well as means of viewing the site/remedial measures. The series of different static view types are replaced with a series of panoramic views. Tab panels show the availability of different case studies, or different remedial measures.

Interface Design V4

2.4 Platform

2.4.1 A reduced window size (from 800x 600 pixels to 760x420 pixels) was initiated in part by investigation of browser usage statistics. This required substantial simplification of the interface.

http://www.w3schools.com/browsers/browsers_stats.asp

Based on the statistics available at the above web site, it was decided to reduce the window size to accommodate the 35% of users still limited to 800x600 screen resolution.

Frames and JavaScript are widely used, so these technologies were integrated in the page structure and tree menu system.

2.4.2 As shockwave was being used as the tool to create the panoramic views, it was decided to bundle the whole scenario (images, panoramas, interface elements, sounds) in as well. Using Shockwave as the delivery mechanism has several advantages:

a) Subtle or complex effects are available rather than the unsatisfactory browser page effects previously used.
b) Motion can be applied to onscreen elements to illustrate speed and movement of vehicles.
c) Sound can be integrated & synched directly within the application rather than requiring separate plug-ins.
d) Copyrighted material cannot be downloaded and saved by the user.
e) Animation and real-time VR could easily be integrated into the application at some future date.

As we always planned to build a fully accessible, wholly HTML version of the site, it was decided that the fully featured version, should take advantage of all the power of Shockwave rather than use it piecemeal.

The full chronology of this development can be seen by browsing the accompanying CDROM or online at:

www.aims-solutions.co.uk/safesite/layouts.htm

2.5 Content Design

2.5.1 Based on technical discussions with HSE staff, a test bed situation or scenario was outlined. The construction of the components and their integration with the user interface is described below.

2.5.2 Wherever possible three-dimensional media from Safe Driver has been reused and upgraded. For this scenario, these included office, warehouse buildings, a truck and other ancillary vehicles.

A new road layout however had to be constructed specifically for this application using CAD software. This ensured dimensional accuracy and geometrical detail (including road markings) suitable for the rendering processes proposed for Safe Site.

Three Dimensional models of equipment

2.5.3 Other newly constructed three-dimensional media included:

a) Bollards
b) Signage
c) Barriers
d) Zebra crossing
e) Pedestrian

2.6 Images Formats

2.6.1 Different image compositions, aspect ratios and file formats were produced as the content varied in relationship with the interface development process outlined above.

A variety of these images are available for review on the accompanying CDROM and at:

www.aims-solutions.co.uk/safesite

Among the images produced were:

a) Plans
b) Perspective views
c) Interactive panoramic views
d) Photomontage views
e) Pedestrian viewpoints
f) Driver viewpoints

2.7 Image Content

2.7.1 Images of individual pieces of equipment were initially produced, as it was envisaged that the user would closely investigate each remedial measure being employed and gather further information on it.

Iconographic representations were used to augment the plan view and to act as placeholders to inform the user as to which part of the larger images was being referred to at any one time.

The concept of seeing the effect of remedial measures was always considered key to the ultimate success of Safe Site. Therefore close attention was paid to how these 'before and after' views. Different techniques were used and tested:

2.7.2 Introducing new or altered elements

Simply introducing objects such as signage proved a powerful tool, especially if all else in the view remained the same. The ability to 'wipe on' one image over another gives the illusion of an object magically appearing in the world.

Illustration of an unsafe site

Illustration of an safer site

2.7.3 Cause and effect

To take this approach one step further we introduced the concept of cause and effect, so by introducing an object into the world, and existing element reacts in a certain way. In one case the position of a pedestrian changes due to the introduction of pedestrian barriers.

2.7.4 Viewpoint change

A similar technique would be to change the users viewpoint in response to the introduction of a remedial measure. For instance, the position of the driver's view changes after the introduction of a speed sign.

2.7.5 Data Augmentation

When remediation is carried out which has subtle or complex effects it may be necessary to augment the view with illustrative elements/data representations to aid clarity and understanding. These representations could include arrows to denote change of speed and/or direction, coloured zones to denote hazardous areas etc.

2.8 Shockwave version

2.8.1 Our recommended solution is a Safe Site Welcome page which contains an overview of Safe Site, its background and goals, access to user help, external links, and links to the HTML or Shockwave versions of the site. Upon entering the Shockwave version the user will be presented with a page containing:

a) A list of topic areas – i.e. Vehicle & Pedestrian Segregation
b) A list of case studies – Based on real accidents
c) A list of possible measures – Lighting, Barriers

2.8.2 Each of these links could be accompanied by a small thumbnail and description of the subject contained within. Clicking this link will launch another window, where the user can explore chosen subject. This can be done in a variety of ways depending on the chosen option:

a) Read or listening to a description of the issue
b) View it from different viewpoints
c) Read or listen to descriptions of various remedial measures
d) Apply and remove the measures back and forth to study their effects
e) View the effects from various viewpoints
f) Read or listen to descriptions of these effects

2.8.3 The user can then close this window (if viewing at 800x600) to access the scenario menu page, or open a scenario viewer in a second window.

?? Browser: Internet Explorer 3, Mozilla/Netscape4 or above
?? Screen Resolution: 800x600 pixels or above
?? Shockwave 8 plug in or above

2.9 HTML version

2.9.1 The HTML version of Safe Site is envisaged, as a fall back option for those unable or unwilling to install the Shockwave plug in. The design should be similar in structure but will lack the interactive and engaging elements of the Shockwave version (panoramic views, animated elements, image transitions, voiceovers)

?? Browser: Internet Explorer 3 or above, Mozilla/Netscape4 or above
?? Screen Resolution: 800x600 pixels or above

2.10 Three-dimensional generated environments

2.10.1 The environments should focus on being realistic as regards the key issues being communicated and every effort should be made not to distract the user with superfluous detail in an attempt to recreate a facsimile of a photograph. However, the site layouts, dimensions, lighting, weather conditions etc. should be sufficiently convincing, to keep the user fully engaged in the issues and solutions presented before them.

2.10.2 Computer generated environments provide the flexibility and control which photomontage does not. The ability to create an environment that exactly illustrates a particular set of issues and then show them from any vantage point easily outweighs the technical challenge of creating them.

2.11 Image Augmentation

A great deal of user immersion and interactivity can be achieved through careful image generation and manipulation. The use of computer-generated environments allows for full motion video to be brought on stream at a later date, should it be deemed necessary and user bandwidth allows.

2.12 Panoramic Views

2.12.1 A high degree of interactivity and immersion that is both photo realistic and web deliverable is available through the use of panoramic views. With this approach the user can look around from a fixed viewpoint, and 'jump' to others by clicking a link on a plan or other image.

2.12.2 We recommend the wide spread use of these views in the shockwave version (they can be locked to control the users viewpoint if necessary).

3 Stage 2

3.1 Interface

3.1.1 As the case study media came on stream and internal testing progressed the design of the interface naturally developed. This process meant that innumerable small changes were made on a daily basis, leading to that shown below:

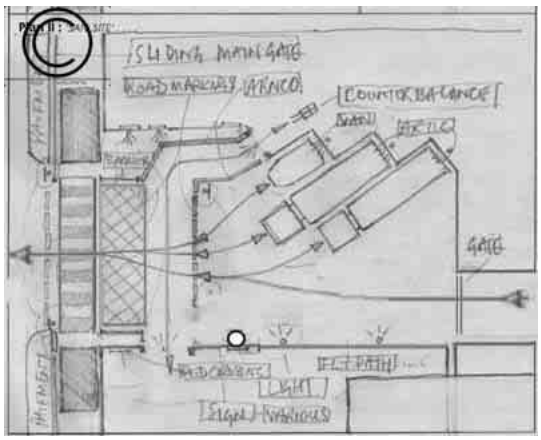
Shockwave user interface

3.1.2 The html version of the interface is based upon the shockwave version in visual appearance. Due to the large amounts of media and numbers of html documents, it was necessary to produce a software tool to automate the production of these documents. Continuing development of the interface meant that it was not always possible to keep the development of the two platforms in synch.

3.2 Case Studies

3.2.1 Data was slow in coming and we had to develop the digital media in its absence, with the hope that they would prove useful when the case studies were finalised. During a meeting with Kevin Jewitt it was agreed that we create fictional case studies based on information found in, Workplace Transport Safety – Guidance for employers (HSG136). We developed scripts and drew up plans that illustrate the 4 accidents in 4 different sites and the remedial measures put in place afterwards. The case studies are entitled:

a) Narrow Street
b) Unsafe Crossing Point
c) Segregation
d) One-way system



Sketched Plan for Case Study: One-Way System

3.2.2 The development of these environments, accident scenarios and suggested improvements will be deemed finally complete after review by HSE experts. Further development work (to script and sketched plan stage) has also been carried out on all four Stage 3 case studies.

3.2.3 Further information also fed into the design process as it came on stream. This information came from HSE documents such as those listed below:

a) Research Report 276 – Safe Sites: Driver's Perceptions
b) Hazardous Installations Directorate: Safety report assessment guidance
c) Roadways / Site Traffic Control / Immobilisation of Vehicles
d) http://www.hse.gov.uk/comah/sragtech/techmeastraffic.htm

3.3 Modelling

3.3.1 Research was carried out into the correct design, configuration, dimension of workplace transport and equipment. This information formed the basis of the 3 dimensional models: various vehicles workplace equipment, workers. Some where transferred from Safe Driver, but many have needed to be remade to fit the specifics of this project, and the type of technology used. Below is a list of models produced for case studies 1-4. This list is typical for all the case studies undertaken throughout the project.

3.3.2 Case Study1: Foreground buildings, background buildings, person, articulated truck, speed sign, pedestrian barriers, swing arm barrier, one-way sign, specific road markings, pedestrian crossing, pedestrian sign, wall mounted flood lights.

3.3.3 Case Study 2: Road layout, Warehouse buildings, raised arm barrier, specific barrier layout (Armco, and pedestrian type), road markings, raised walkway.

3.3.4 Case Study 3: Newspapers (on pallets, and bundles), large counter balance forklift, delivery van (2 types), wheelie bin, road markings, road layout, warehouse buildings (with interiors), delivery trolley, freestanding floodlights, bollards (fixed)

3.3.5 Case Study 4: Tanker, Bollards (retractable), raised stock conveyor, LCD speed sign (with camera), warehouse buildings (4 types), raised road sections (speed bumps), specific lighting, roll cage and person, skip.

3.4 Animation

3.4.1 We produced a test version of this suggested feature, not included in the original specification. The solution was to replace standard digital animation, (which can have large bandwidth requirements) with the same technology already developed for the rest of the site. Using the cross fade that currently shows the before and after states of the site, several more steps were added to illustrate the accident in progress. By cross fading between these frames a degree of motion can be introduced, while still allowing panoramic interactivity.

3.4.2 Positives:

a) Low bandwidth
b) Uses existing programming, developed for the core application
c) Integrates seamlessly with the 'look and feel' of the other panorama images

3.4.3 Negatives:

a) Jerky playback to keep bandwidth low
b) Low resolution to keep bandwidth low
c) Time consuming replication of existing panoramic views
d) Questionable benefit if not an accurate depiction of the accident

3.5 Interactive Plans

3.5.1 The interactive plans are very important in allowing the user to understand the layout of the site, the sequence of events, and hoe the improvements helped to make the site safer. The plans also function as a navigation device, loading images and text, and changing the users point of view in the panoramic viewer.

3.5.2 Special attention was paid to the appearance and legibility of the iconography in this part of the site.

3.6 Images

3.6.1 Digitally rendered panoramic images were created to show the state of the site before the accident, immediately after the accident, and after the improvements were made to the site. Special care was taken to ensure the layout, point of view, and environmental effects are both realistic and illustrative of the message

3.6.2 Thumbnail images show detail sections of the site, drawing attention to certain aspects of the scene. Details that are not in the scene, such as alternative equipment can also be shown.

3.7 Additional information

3.7.1 The basis of any voice over has been outlined as part of the case study script. However at this relatively early stage (prior to expert review) it had been decided that the time consuming process of recording and editing the audio should be postponed.

3.7.2 To create a photo realistic “window into the site”, that is as engaging as possible for the user, it was decided that the plan view be used to illustrate vehicle paths and other data.

3.7.3 This web-based application was never conceived to be a comprehensive guide to all aspects of safe site design. Rather it was to illustrate some of the issues, and they could be avoided. Therefore it is important that there are links to extra contextual information via other HSE sources. These links are available in the bottom right of the interface, and are context sensitive, providing links to topics that relate to the issue currently being displayed.

3.8 Testing

3.8.1 The software itself is in a daily process of testing, on various operating system, browser and Internet configurations. The content is appraised internally against HSE guidance notes and research documents (see 3.3 Case Studies) at regular development meetings.

3.8.2 The software and content is available for review on-line at:

http://www.aims-solutions.co.uk/safesite

Regular meetings with HSE staff have been an important part of the project development to date. We expect this to increase, as a wider group of interest groups gain access to the site, and feedback their opinions.

4 Stage 3

4.1 Work undertaken in Stage 3

4.1.1 Scripting and development of accident case studies 5-12 continued, culminating in the complete list of case studies, as shown below:

1- Narrow Street
2- One way system
3- Segregation
4- Dangerous crossing
5- Pedestrian forced into path of car by poor paving
6- Pedestrian hit by car while crossing busy road
7- Lorry hits pedestrian crossing construction site
8- Excavator kills member of public on waste transfer station
9- Tractor hits children playing on farm
10- Van reversing on narrow street hits car
11- Reversing lorry hits pedestrian amid chaotic parking
12- Delivery driver hit by car on busy street

4.1.2 3D models and rendered illustrations of the unsafe environments and the accidents in Case Studies 8 & 9 were produced.

4.1.3 3D models and rendered illustrations of how remedial action could be carried out to prevent further accidents in Case Studies 8 & 9 were produced.

4.1.4 A high visibility HTML based web site intended for users with visual impairment was created. This site also provided access for HSE staff without access to Shockwave.

4.1.5 Several iterations of changes were made to the Shockwave interface to improve the user experience.

5 Stage 4

5.1 Work undertaken in Stage 4

5.1.1 Development of accident case studies 5-12 continued, based on feedback from Mike Chater (Atkins).

5.1.2 Illustrations of the unsafe environments and the accidents in Case Studies 6,7,10,11,12 were carried out.

5.1.3 Illustrations of how remedial action could be carried out to prevent further accidents in Case Studies 6,7,10,11,12 were carried out.

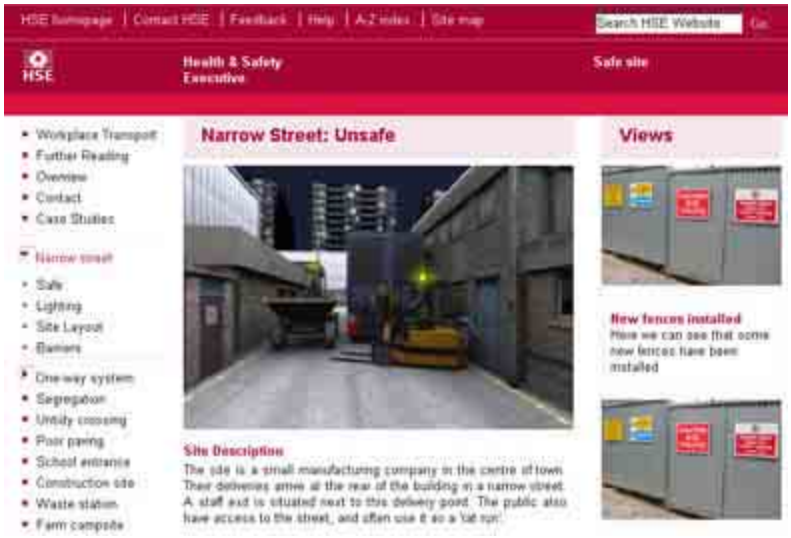
5.1.4 Updates to the high visibility HTML based web site intended for users with visual impairment.

6 Extension

6.1 Work undertaken in the Stage 4 extension

6.1.1 Several iterations of amendments were carried out based on feedback from Mike Chater and HSE staff. These focused on the panoramic images and text panels.

6.1.2 The 'high visibility' HTML site was rebuilt using the HSE web page templates and style sheets. This allowed the safe site pages to fit easily alongside the workplace transport web pages, and comply with the HSE accessibility standards.



Hi visibility web site transferred to HSE template and styles

6.1.3 Photographic thumbnails form a counterpoint to the extensive use of computer-generated imagery. They have the benefit of being quick to produce and provide a 'real world illustration of the issues being discussed. Care was taken to remove any identifying name or logo. Close up or detail views were often used so not suggest that the site portrayed was in any way 'ideal'.

7 Conclusions

7.1 Redundant elements

7.1.1 As referred to in section 3.5.3 the use of animation has several drawbacks. We carried out some tests that highlighted not only these, but also suggested that the media would replicate functionality already in place by other means. It was therefore decided to drop that part of the application. Should user feedback show that the site would benefit from moving images, these could be integrated at a later date.

7.1.2 The use of voice-overs in the shockwave version to describe the site layout is without real benefit as the application makes such large use of visual media. Also, for this to be truly useful, every element of the user interface would have to have speech associated with it, not just the text descriptions. It could also be argued that the HTML version (which can be accessed by using text to speech software) meets this requirement.

7.1.3 The ability to use choose a piece of equipment and then step through the case studies in which it is used, proved to be more of a hindrance than a help to the user. Without a good understanding of the case study, seeing where equipment was used was of little value. The user had to read the case study background in any event, making this mode redundant and it was subsequently removed.

7.2 Specification and delivery

7.2.1 The initial specification identified that three generic sites of varied sizes and ages would suffice to illustrate the issues and their remediation. It was also assumed that the tool would focus on the use of various pieces of equipment (barriers, lighting etc) in the remediation of these sites. However, as the project progressed it became apparent that the history, background and particular circumstances of a site were key

to the issues encountered. Also behavioural or managerial practices played a part in the safety issues.

7.2.2 Fictional case studies were developed and these drove the direction of the project from then on. The development team planned and scripted these, with feedback from HSE staff. This extra development work put pressure on the original schedules and lead to the required project extensions.

7.3 Technical advice and case study design

7.3.1 The key importance of the case studies should have lead to the early involvement of a technical advisor to liase with the development team in their design and development. The additional expertise of a technical advisor would have allowed the development team to make informed decisions rather than intuitive guesses as to what type of case studies were required and more importantly what improvements were necessary and reasonable.

7.3.2 The involvement of the Mike Chater from Atkins, later in the process greatly helped the development team, and his earlier involvement would have been improved the case study development process.

7.4 System integration

7.4.1 The process of integrating the application into the HSE web site began late on in the project. While the process has been relatively painless, the design of the whole application may have benefited from the earlier involvement of the web integration team. For instance, the development of the mid-level and ultimately redundant HTML site would have been avoided.

7.4.2 In the absence of HSE guidelines on the production of web based multimedia applications, closer collaboration with the web integration team would undoubtedly have been beneficial.

7.5 Future development

7.5.1 It is hoped that feedback from users and from within the HSE proves to be positive, and that additional content would be welcomed. While the system is not completely modular, further case studies could be integrated relatively easily. In this event, the use of real accident case studies as a basis of the illustrations could add a great deal of impact to the experience. This approach could also speed up the development process, as the task of designing generic case studies should not be underestimated.

7.5.2 Closer integration with the HSE multimedia guidelines could be achieved by moving the delivery platform across from Macromedia Director to Macromedia Flash. Flash has the advantage of over 90% availability on PC systems worldwide. There would be a small loss of functionality and the costs of such a move may outweigh the access benefits. In this event any new case studies could be integrated into the existing interface with only minor additions and changes.

Printed and published by the Health and Safety Executive
C1.10 06/05

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RR 361

£20.00

ISBN 0-7176-6134-2

9 780717 661343