



Further development of an IIG/HSE e-learning health and safety risk education package for engineering undergraduates

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Further development of an IIG/HSE e-learning health and safety risk education package for engineering undergraduates

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This report describes work carried out jointly between the author, Logica CMG and the Health and Safety Laboratory to develop a 'sample' or 'demonstration' e-learning package to teach undergraduate engineers of all disciplines about the key concepts relating to health and safety risks. It is based on outline teaching material developed by a sub-group of the Inter-institutional Group on Health and Safety and on subsequent work carried out by the author and Logica CMG which has recently been published as a HSE Research Report (RR452 - see: <http://www.hse.gov.uk/research/rrhtm/rr452.htm>).

The eventual aim of the project is to produce a complete e-learning package containing core material on health and safety issues for the potential use of all engineering departments at UK universities. It should also meet requirements in this subject area to enable candidates to achieve chartered engineer status. The approach has been designed to be modular and flexible so that users can adapt it to their specific needs, whilst being interesting and enjoyable in use.

In the current phase of work (phase 3), key elements of the proposed final package have been assembled in such a way as to make the approach being taken clear to stakeholders so that feedback can be obtained and routes for further support identified and explored. This report describes the selection of topics used in the sample and the process involved in developing it. The sample is in the form of a CD and contains introductory material, a simulation and related tutorial material developed for learning in a 'gaming' context, and several illustrative examples of other interactive tutorial material.

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EXECUTIVE SUMMARY

This report describes work carried out jointly between the author, LogicaCMG and the Health and Safety Laboratory with input from the Health and Safety Executive. It follows up work carried out previously to develop an e-learning package for teaching undergraduate engineers of all disciplines about key concepts relating to health and safety risks. The earlier work (referred to as Phases 1 and 2), involved preparatory work by a sub-group of the Inter-institutional Group on Health and Safety (the IIG). It defined learning outcomes and made suggestions for technical content ⁽²⁾ and then developed these ideas to 'proof of concept' stage, using an e-learning approach, with feedback from a wide range of stakeholders ⁽¹⁾.

The present work (phase 3) involves the production of a 'demonstration' or 'sample' of introductory, background and actual teaching material, building on the concepts and content developed in the earlier phases of the project. The production of this sample is designed to give further confidence in the effectiveness of the approach and methods suggested, to allow the very valuable feedback from stakeholders which emerged from phase 2 to be taken into account and, most importantly, to provide an attractive vehicle which can be used to generate support for the proposed production of a fully developed package (phase 4). The 'sample' therefore contains both explanatory material to inform stakeholders about the background to the project and its intent, as well as developed examples of the various types of content which might appear in a full teaching package.

It has been designed to show how the proposed approach can provide not only a memorable, interesting and stimulating framework for teaching and learning, but also a flexible, modular structure designed to meet the needs of a university engineering department, possible accreditation requirements for Chartered Engineer status, or be used for training young engineers in the subject in organisations such as industrial companies.

The approach involves three 'layers'. The first is in the form of interactive material based on 'gaming' techniques. It is proposed that the student user joins a small 'virtual' team of young graduate engineers in a 'journey' involving four simulated projects. She or he becomes engaged in the debate and decisions which have to be made by the team. The second 'layer', supporting and emerging from the four projects, involves a range of tutorial material produced in a form which involves the user in simple but thought-provoking exercises with feedback on progress. Both of these layers can be used flexibly and adapted and augmented to meet specific needs. The final 'layer' is designed to be available specifically to meet the requirements of a particular teaching organisation. It could be populated, in due course, with a wide variety of material to meet specific needs.

In this phase of the project, examples of each of these inputs have been produced in an e-learning context. A CD has been developed which contains the following:

- an eye-catching set of video clips highlighting the importance of the issues being considered;
- introductory material (including a sleeve for the CD) which explains the background, content and future intentions for the project. Guidance is also given on how the material can best be used;
- a draft simulation of a construction site. This is in the form of a 'video game' where the user is asked to spot hazards, given guidance on the impact and nature of the hazards and introduced to the concept of risk assessment with appropriate input and feedback;

- a variety of tutorial material (which can be related to the simulations or can stand alone). In this ‘sample’, material has been included on comparing risks, factors affecting risk perception, an introduction to terminology (specifically ‘risk’ and ‘hazard’) and an example of background briefing material (in this case on the concept of ‘reasonable practicability’); and
- a concluding section, drawing together the strands from the above and soliciting help with further development.

The report explains why and how this subset of material was chosen and the process used to deliver the material in an attractive format on the CD. Recommendations are made for the immediate next steps to be taken before proceeding (given continued interest, commitment and resources) to the development of a full teaching package (proposed phase 4).

1. INTRODUCTION AND BACKGROUND

The Inter-institutional Group on Health and Safety (consisting of representatives of the expert groups and secretariats of the Institution of Engineering and Technology (IET, the former IEE), the Institution of Mechanical Engineers (IMechE), the Institution of Civil Engineers (ICE), the Institution of Chemical Engineers (IChemE), the Hazards Forum, the Ergonomics Society and the Safety and Reliability Society. It has been working over the last few years to develop stimulating and thought-provoking material for universities to use as a toolkit in teaching undergraduates about risk in the context of health and safety. Initial work considered learning outcomes and identified source material. This was followed up by the production of a document by a sub-group involving academics, the HSE and other experts, which proposed the topics which might be included in teaching material ⁽²⁾. The intention was that the material would be applicable to all engineering students irrespective of their specific engineering discipline.

This work received strong support from the Engineering Institutions, the HSE, and the Engineering Council (UK) (which saw it as a useful potential source for meeting accreditation requirements) as well as the Engineering Professors' Council (EPC) and several universities. Although not aimed directly at industry, major companies to which the summary report was submitted, reinforced both the need for the material and offered general support for the project and its outcome. In two cases, they saw the material as a potential source for internal training. This early work carried out by the IIG and its expert group, will be referred to as 'phase 1' of the ongoing project.

Last year, the project moved to a second phase with financial support from the HSE. The IIG Sub-group continued to offer oversight on behalf of the Engineering Institutions and the Engineering Council (UK). The project is regarded by the HSE as an opportunity to raise awareness of such issues in an educational context and in so doing, as a contribution to meeting objectives in its strategic document "Revitalising Health and Safety" ⁽³⁾. The intention of this phase was to show 'proof of concept' and to move from a paper presentation of issues to the definition of requirements and approaches for actual teaching material. This work proceeded with continued input from several of the above stakeholders, but also benefited from the strong involvement of a company (LogicaCMG through their HSE support organisation 'Refit') with a strong track record in providing similar material in an e-learning format for a variety of government and industry applications. The result was that a novel e-learning package was developed in concept, which incorporated nearly all of the identified teaching material in a way which was thought likely to appeal to the end user.

Three 'layers' of material were proposed. The first were simulations of a team of three young engineers undertaking a range of projects as part of their graduate training with a major company. In carrying out these projects, they address and discuss the identified issues. The second 'layer' consisted of briefing material, interactive exercises and assessments. The third 'layer', which would be accessible from the package of material proposed, would be populated by university departments to meet their specific needs.

The proposed content of the teaching material (and the way that this might be presented in an e-learning context together with stakeholder views and comments, and recommendations for further work) was the subject of an HSE Research Report ⁽¹⁾. In this, it was concluded that a clear overall concept and structure had been developed for the teaching material based on the proposed e-learning approach. This incorporated the IIG's outline of technical content.

A presentation package was developed which was used to explain the approach being proposed to a range of stakeholders, including the IIG, several potential end users in universities

(including students) and several major companies. Feedback was summarised in appendices to the Report and was generally very positive with many useful suggestions for further development. Overall, it was thus concluded that the project could move forward to a further phase of work with confidence that the approach was likely to be practicable, meet end-user requirements and be an attractive and interesting package in a learning context.

The main recommendation of the report was that given uncertainties about cost, timescales and some logistical issues and the need for good quality, realistic material to explain and support the proposed approach, a ‘demonstration’ or ‘sample’ module should be developed. The development of this material is the subject of the present report and is referred to as ‘phase 3’ of the planned project.

2. PURPOSE OF PHASE 3

The purpose of the work described in this report is to follow up the main recommendations in phase 2 and produce a ‘demonstration’ or ‘sample’ of proposed teaching material, drawing on both the proposals and the earlier IIG content. Not only would this give greater confidence about some of the uncertainties recognised in phase 2 and allow some of the feedback from stakeholders to be taken into account but, most importantly, could provide an attractive vehicle which could be used to generate support for the production of a fully developed package along the lines proposed. (See recommendations below)

3. DEVELOPMENT OF PHASE 3 CONTENT

The core of the proposed e-learning package is again based on a simulation of the activities of the three newly-recruited graduate engineers working as a team for a major international company. It is intended that students identify with these young engineers and are invited to enter into debates which take place between them during the simulations. The team members develop different views about the issues and the student user participates in the debate and has to arrive at conclusions and make decisions. Following the simulated discussion, the student is given a short brief, an interactive exercise and an opportunity to develop his or her own views and check understanding.

The background against which this takes place is a scenario in which the three young engineers, as part of their training programme within their company, are sent as a team to be involved in and to learn from four projects which takes the form of a virtual “journey”.

The four projects chosen are given as examples and may be adapted when the package is more fully developed. The projects currently suggested are:

- a) flying by aircraft and helicopter and spending a week with a risk assessment team on a North Sea oil platform;
- b) helping to identify and deal with risks at a construction site where new facilities are being built for the company;
- c) involvement in the design and production of a practical device (such as a wind turbine) to meet local needs in a developing country (a community project); and
- d) involvement in the investigation of a major incident at a company plant, where ‘people’ issues and organisational factors have had an important part to play in the event.

Each of these projects is designed to provide a platform for a range of tutorial material. Taken together, the projects and supporting material will cover nearly all of the topics originally

proposed by the IIG group in phase 1. Appendix 1 of this report summarises the learning outcomes and the topics introduced as part of each of the project activities.

It was also suggested in phase 2 that the package should begin with eye-catching examples of why the good management of health and safety risks is vital. It was proposed that this might be done using video-clips of major disasters and by engagement with the personal stories of those who have been affected by serious industrial accidents. This suggestion has been adopted and material formulated to meet this requirement.

The intention of phase 3 has been to produce high quality material as an example of what is proposed. Difficult choices have had to be made about what simulations and tutorial material might best be included at this stage. It was concluded that the choice of 'sample' material should include introductory material which puts out a strong message about the importance of the subject and the project, an example of an actual simulation using a 'gaming' approach and some examples of tutorial material which would also involve and engage the user. These elements should not only give a clear picture of what is proposed, but also give an indication of how the teaching package is designed to be modular and flexible and to provide opportunities for university and engineering departments and other potential users to adapt it to meet their own requirements.

The following material was therefore chosen for inclusion:

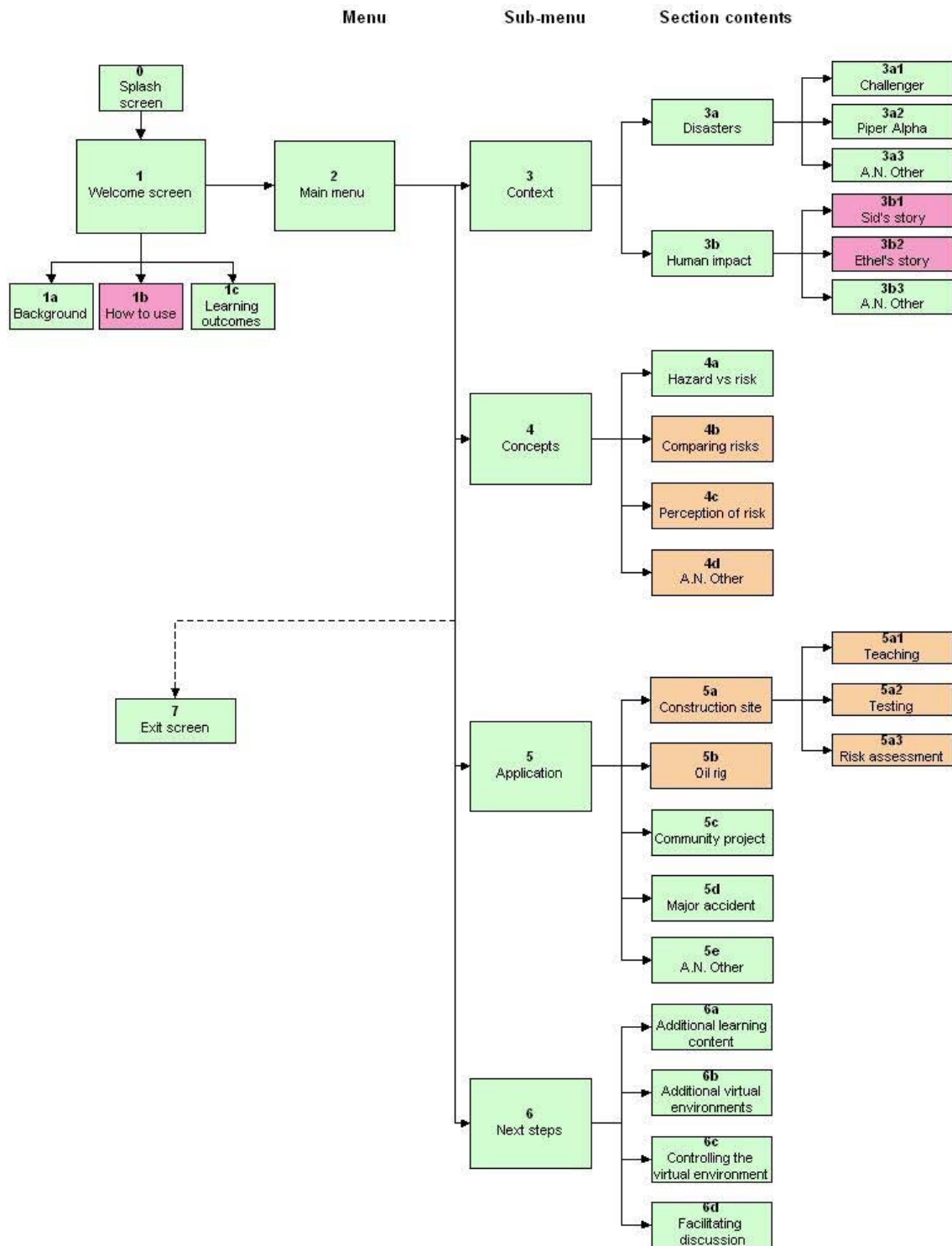
- an introductory explanation of the history and intent of the project;
- video clips of major industrial disasters and the impact of accidents and occupational ill health on people. (We are grateful to BNFL plc and the HSE for making material available for this section);
- explanatory material outlining the purpose, possible mode of use and future intentions in relation to the development of a full package of teaching material.
- the learning outcomes associated with a complete package;
- a virtual construction site which engages users and introduces them to the concept of risk assessment through a hazard-spotting exercise; and
- a selection of tutorials illustrating the proposed 'layered' approach to the package. It was decided at this stage to develop material aimed at raising awareness of relative risks and the factors influencing perception of risk. Both sets of material use an interactive approach. A brief was also provided on the important health and safety concept of 'reasonable practicability' as an example of how more conventional teaching material can be added to the package.

The material developed for the 'sample' therefore contains about one sixth of the currently envisaged complete package of material.

Discussions between the participating parties in the project led to the proposed overall structure for a complete package shown in Figure 1. This shows the hierarchy of menus in the contents and also shows what has currently been developed as well as those parts which have not. It starts with a welcome screen which provides links to the 'background', learning outcomes and information on 'how to use'. The main menu leads to the four main sections of the CD containing the disaster videos and the human impact stories, concepts/tutorial material, simulations/applications and a section on next steps. In each of the main sections, additional boxes illustrate how further material can be developed in due course and added to the framework shown. One additional feature of the 'sample' is the inclusion of a short, self-standing description of the intent of the project, an outline of the content and approach and a request for further input from stakeholders who may wish to contribute financially or

intellectually to the further development of the teaching material. This was prepared specifically to convey the key messages to senior people in stakeholder organisations who may not have time personally to go through the material in detail, but who may wish to get an overall impression of what is intended.

Figure 1



4. PRODUCTION OF THE CURRENT MATERIAL

The development of the limited sample of material over a period of about four months (March to June 2006), required input from several sources in order to:

- develop an overall structure and clarify the inter-relationship of the various elements;
- provide content and associated spoken material (voice-over), script for screens and background images for the introductory material;
- obtain, review and edit a collection of video clips and supporting spoken material for the eye-catching introduction;
- facilitate the simulation of the construction site by identifying a range of hazards for simulation, agree the way that this might be done in a realistic way and provide suitable briefing and feedback material on hazards and risk assessment;
- provide tutorial material and interactive exercises, together with spoken material, script for screens and images for associated screens; and
- provide spoken material, script for screens and images for the 'Executive Summary' and concluding sections.

The process employed required a disciplined, ordered approach so that inputs from the various sources could be subject to comment in a controlled way. Each part of the process had an 'owner' who was responsible for developing draft material, editing this and passing agreed material on to those leading the next phase of development. The process was thus effectively one of three stages:

- production of initial, agreed, technical input;
- conversion of this into screen images and spoken words (as voice over) in the form of scripts; and
- development from this to the presentation e-learning package on a CD, with opportunities for checking and feedback from participants.

An outline of the process used for the production of the material is given below.

- The author prepared a technical brief for each topic. Examples of such draft technical briefs are shown in Appendix 2. These were retained in the form of a master version and comments/inputs from each of the participants in the project and from HSE experts (where required) were edited into the master script as tracked changes to each source document under the control of the technical author (RHT)
- LogicaCMG translated each of these briefs into a script. An example of one page of such a script is shown in Appendix 3. These were circulated for comment to all participants and tracked changes were agreed under the control of the scriptwriter (SV). A typical script includes, as shown, a description of the screen, spoken material and a representation of graphics or any simulation
- LogicaCMG then translated the script into e-learning material on a draft CD. In this first version, identifiers were given for each screen, and members of the project team provided comments on audio, visual and functional elements using a common amendments sheet, which allowed LogicaCMG to respond to the comments and suggestions made. Issues that could not be resolved by correspondence using this method were discussed at project meetings.

Production of the simulation of the construction site followed the same general process. A draft list of potential hazards which might be simulated was drawn up by the author, together with a simple brief on the issues involved and their importance (see Appendix 4). A useful source document for this was the HSE Guide “Essentials of Health and Safety at Work”⁽⁴⁾. To obtain realism in the actual simulation, further expert advice was sought from other sources. Input was obtained from the manager of a construction site, from an HSE expert inspector on construction site safety and from other HSE experts in relation to specific issues (e.g. electrical safety).

The main issue in translating script into a student interface, related to functional requirements (navigation around the site) and clarity about presenting the hazards. A system was adopted where, during an initial ‘hazard spot’, the user is invited to identify a potential hazard and feedback was given both on the site simulation (through the appearance of a simple ‘flag’) and as a response to a ‘notebook’ on screen, through which the user is invited to identify, make notes on the hazard and submit these for acceptance or rejection.

Following the initial unguided ‘hazard spot’, the intention is that the user would be able to carry out a further virtual site tour, this time with tutorial input and guidance. The user would also be invited to submit a simple risk assessment on a small number of hazards and feedback given. The approach to risk assessment is based on the HSE’s publication “Five Steps to Risk Assessment”⁽⁵⁾.

In developing this simulation further at a later stage of the project, further opportunities exist (in line with the proposed learning outcomes in Appendix 1) to provide exercises on issues such as the costs associated with accidents and ill health at work and the professional, ethical and legal requirements on engineer. The importance can also be emphasised, and guidance given, on the human dimension involved in improving health and safety in the field.

5. THE INTERACTIVE LEARNING SAMPLE PACKAGE

It was agreed by the project team that for ease of production and to assist actual face-to-face presentation of the 'sample', the final version of the material would be in the form of a CD. A limited number of these are available from the HSE by email: risk.education@hse.gsi.gov.uk or telephone: 0151 951 5856. As noted in Reference 1 however, it is intended that the final package of teaching material would be web-based rather than circulated on CD.

In addition to a description on the CD of the project and its context and future direction, a simple CD 'sleeve' was designed which contained the same information. In both cases, contact details are given through which feedback and comments on the 'sample' would be collected for consideration in any later phase of the project.

Because the CD is a sample, prepared to tight timescales, it has not been produced to the same quality standards as would be required for a fully developed package. It is only designed to show what is possible. Although material was checked and content monitored using the systematic approach described in section 4, it is likely that errors and omissions will be present. At this stage, the project team felt that the timely circulation of 'sample' material for comment and feedback was more important than detailed quality checks and wider expert comment before producing the CD. We invite users to bear this in mind in providing feedback and comments on the present material.

6. CONCLUSIONS

This phase of the project has enabled several conclusions to be drawn.

- The primary intention of the work was to produce an attractive, good quality ‘sample’ or ‘demonstration’ which would enable future contributors and/or funders of a full e-learning package to understand and see clearly what is intended and to have confidence that it can actually be achieved. A suitable sub-set of the material developed to ‘proof of concept’ in phase 2 of the project has now been produced to meet this objective. This completes and addresses the main recommendation of the previous report.
- The ‘sample’ is estimated to contain about a sixth of the material which would comprise a final package. It has taken about four months to progress from early discussion on possible content through to the final CD. This reinforces the view expressed in phase 2 of the project that, with further preparatory work (see below), about 1 year might be required from agreement on funding to production of the final product.
- The development of the CD described in this report has demonstrated the care, clarity and control that is required to avoid substantial rework (and thus increase in cost) in a project of this sort. A process has been developed, which with some modification, should provide a basis for the efficient production of complete teaching package. The use of such a process will add confidence to the estimates of cost and timescales and quality standards. Within this process there is the need for clearly identified lead people to own and be responsible for each phase of production, namely:
 - Production and review of good quality technical briefs.
 - Translation of briefs into scripts which provide a combination of audio. and graphical material, taking account of user needs and capabilities.
 - Production and trial of draft e-learning material on a CD.
- If a full teaching package is now to be developed, this will involve by its very nature, a greater number of inputs and interactions. It is therefore also concluded that the current process needs to be further considered in the context of a much larger project. In particular, a project plan including consideration of possible phasing of future work should be developed. This would also take account of the logistical issues raised in the conclusions above. Further consideration is also needed on how technical input can best be obtained and managed.

7. RECOMMENDATIONS

- The main recommendation from this phase of work is that the CD is used as a vehicle to promote further interest in the project from potential users and sources of future funding. In the report on phase 2, three potential sources were identified: a) government departments and agencies; b) industry and c) charitable bodies.
- It is recommended that a series of presentations using the CD be arranged with representative organisations in order to assess the likely level of support and funding for the development of the envisaged teaching package and to seek commitment, wherever possible, to support this.
- It is recommended that a more refined estimate of costs for the full package now be obtained. This should be based on information from the costs incurred in the production of the material contained in the current CD and will be an important input into the discussions proposed above.
- If the proposed further simulations with their supporting interactive tutorial material are to be developed, further consideration should be given to the way that this can best be done and where sources of the relevant expertise can be obtained. For example certain simulations may be of specific interest to particular industrial organisations. They may also be able to provide further ideas on the content and technical basis for such simulations.
- The sample and new material need to be reviewed and further consideration given, based on stakeholder feedback, on how to develop the present material into a full package of interactive, user-friendly material. Research could use focus groups or individual, verbal ‘walk through’ techniques to elicit users’ opinions of the programme. This will enable the designers to finalise the product in line with end-user requirements, thus lending increased confidence from users that as the tool should meet their expectations.
- The current work has used a process which is likely to provide a suitable framework for the development of a full package. However, it is recommended that further consideration be given to logistical issues based on the experience described in this report. For example, the inclusion in a further phase of the project of more authors of technical material has the potential to increase the interactions required with scriptwriters and producers of the final product. Before embarking on the production of a full teaching package, consideration should thus be given, not only to the identification of the inputs required as above, but also to the phasing of further work, the development of an associated project plan and the need to appoint an overall project leader or ‘producer’, responsible for integrating the work and facilitating its smooth production.
- Consideration should be given to ‘ownership’ and copyright matters. It is expected that options regarding these matters will emerge from the proposed discussions with stakeholders.
- In the report on phase 2 ⁽¹⁾, recommendations were made with regard to; a) further exploring the potential role of the Higher Education Academy Engineering Subject Centre in promoting the package and providing support in the use of a full teaching package through their contact with the universities and b) ensuring the continued support and role of an enlarged IIG group in sponsoring and providing suitable advice and input to the project. These recommendations have not changed as a result of the current work and continue to be supported.

8. REFERENCES

The references have been arranged in numerical order as they appear in the document.

1. *Development of an IIG/HSE e-learning health and safety risk education package for engineering undergraduates*, HSE Research Report 452, 2006.
2. *Outline of Proposed Undergraduate Engineers' Teaching Material on Managing Risk*, Produced by the IEE (now IET) on behalf of the Inter-institutional Group on Health and Safety, 2003.
3. *Revitalising Health and Safety – strategy statement*, HSE and DETR, HMSO, OSCSE0390, 2000
4. *Essentials of Health and Safety at Work*. HSE Publications, ISBN 0 7176 0716 X, 1994. (currently being revised for re-publication)
5. *Five Steps to Risk Assessment*, Health and Safety Executive, 1994

APPENDIX 1

Learning outcomes and key concepts arising from the simulated projects

1.1 Learning outcomes

1.2 Key concepts relating to each simulated project

1.1 LEARNING OUTCOMES

Following the approach contained in the document “Incorporating Safety, Health and Environmental Risk Issues in Undergraduate Engineering Courses”, published on behalf of the Inter-Institutional Group on Health and Safety by the Institution of Electrical Engineers (now the IET), four levels of capability have been considered in relation to the learning outcomes of the project. These levels are those originally published by the Joint Board of Moderators in their publication, ‘Guidelines for an accredited B.Eng. honours degree’, Annexe C, August 1998.

Level	Description
A	Appreciation and awareness: be able to refer to something
K	Knowledge and understanding: be able to explain something
E	Experience: be able to do something with help and/or closely supervised
B	Ability : be able to do something without supervision

The following broad capabilities have been identified as outcomes for completion of the teaching material as it is currently designed and envisaged:

1. An understanding of the difference between terms such as risk and hazard (K).
2. An appreciation and awareness of how different risks encountered in life compare, based on a critical assessment of statistical information and scientific knowledge (A).
3. An ability to calculate and compare the annual risks arising from some everyday activities (B).
4. Knowledge and understanding of why perception of risks is sometimes different from statistics and what factors can influence this (K).
5. An appreciation that absolute safety cannot be achieved and that, in practice, costs and benefits have to be balanced, taking account of the views of stakeholders (A).
6. An ability to use some simple techniques to compare cost and benefit (B).
7. Knowledge of the basic concepts and legal requirements in the UK for the management of health and safety and the responsibilities of the individual (K).
8. An understanding of the ethical requirements on an engineer to take responsibility and act appropriately when health and safety risks appear unacceptable (K).
9. An ability to identify health and safety hazards and poor practices in certain environments (B).
10. An understanding of the principles involved in risk assessment and of how a hierarchy of control can be employed in the management of health and safety risks (K).
11. An ability to carry out such assessments in relatively simple cases (B).
12. An understanding of the importance of the human, financial, legal and reputational costs involved in industrial accidents and ill-health (K).
13. An ability to carry out simple calculations of potential loss as a result of accidents (B).
14. An awareness of the need to consider risk from “cradle to grave” in the setting of a project and the importance of good design and planning in minimising later risks (A).
15. An ability to put this knowledge into practice, with suitable guidance, in a practical project (E).
16. An ability to refer to examples of successes and failures drawn from actual engineering experience which illustrate the need to control risks at all stages of a project (A).
17. An understanding of how human factors can influence success or failure in engineering and an ability to provide examples of where the human factor has been of key importance in engineering decision making (K).

18. An ability to explain why accidents are often complex and involve the breakdown of successive defences against failure and that these failed defences usually involve people, processes and organisational factors, as well as failures of engineered systems (K).
19. An ability to demonstrate an understanding of the above complexity by analysing, with facilitation, chosen case studies using available documentary evidence from investigations.(B)
20. An understanding of how open reporting and learning from previous experience can be used to minimise future risks (K).
21. An understanding of the key steps in conducting a simple accident investigation (K).
22. An understanding of the concept of safety culture and the importance of good communication, effective leadership and a rigorous and prudent approach as key factors in achieving high standards of safety (K).

2. KEY CONCEPTS RELATING TO EACH SIMULATED 'PROJECT'

Project 1 – Oil Platform

The proposed issues to be addressed and tested are:

1. Terminology – the difference between the terms 'hazard' and 'risk'
2. Some engineering and human issues relating to work in a high hazard environment
3. The relative risks of different activities and occupations
4. Perception of risk – why do people view risks differently?
5. How safe is safe enough? – achieving the balance between safety and cost

Project 2 – Construction Site

The proposed issues to be addressed and tested are:

1. Identifying hazards
2. Controlling risks - carrying out a risk assessment
3. The costs of accidents and occupational health
4. The legal framework for health and safety in the UK
5. Our responsibilities as individuals – ethical considerations and codes of conduct for engineers – dealing with the “people” aspects of workplace health and safety

Project 3 – The community design and construction project

The proposed issues to be addressed and tested are:

1. Managing health and safety risks throughout a project – 'cradle to grave'.
2. Assessing and deciding on the balance of safety and costs in a real project.
3. Taking account of the 'human factor'.
4. Examples of success and failure in the management of health and safety risks in past projects.

Project 4 – Learning from accidents

The proposed issues to be addressed and tested are:

1. The importance of learning from past events
2. The key elements in an accident investigation

3. The importance of management systems and controls and of organisational issues in safety
- 4 The need for “defence in depth” and the complex nature of the causes of many accidents with reference to latent failures and Reason’s “Swiss Cheese model”
5. The concept of safety culture and our role in contributing to it (through leadership, good communication, encouraging learning and in promoting a questioning attitude).

APPENDIX 2

Examples of draft technical briefs

- 1. What is the difference between ‘hazard’ and ‘risk’**
- 2. Comparing risks – looking at the statistics**
- 3. How do people view risks?**

DRAFT

1 WHAT IS THE DIFFERENCE BETWEEN 'HAZARD' AND 'RISK'?

The terms 'hazard' and 'risk' are used interchangeably in everyday life. Nevertheless, they actually have quite different meanings and we need to be aware of this difference. Put at its simplest, a hazard is a state of affairs or something that can cause harm (e.g. chemicals, an object on a scaffold which might fall on somebody, high voltage electricity, a mechanical tool etc.). Risk is the chance (big or small) of harm actually being done as a result of the hazard.

The Health and Safety Executive define a hazard as, "...the potential for harm arising from an intrinsic property or disposition of something to cause detriment". Thus a hazard is a state of the world or a state of affairs which could result in harm. It is the way the world is at a point in time. A hazard may be in the past, present or future.

HSE define risk as, "...the chance that someone or something that is valued will be adversely affected in the stipulated way by the hazard". Thus risk is the chance of something occurring as a result of a hazard at some time in the future, combined with the consequences that might flow from that hazard, set in a stated context. Note that a risk is in the future and depends upon three factors – a defined and particular consequence of the hazard (death, serious injury etc), the chance that this will occur, and the context of the risk (for example, the risk associated with an industrial hazard would be regarded differently to the risk associated with a leisure activity even if the consequence and chance appear to be the same). How we perceive risk and think about it in context will be discussed later in the course.

As an example, a can of solvent safely stored on a shelf will present a hazard if it is toxic or flammable, but very little risk. However, when it is taken down and used, harmful vapour may be released and there is a danger of spillage and of it igniting. Things get worse if it is spilt and even worse if the spillage is not contained. The *risk* arising from the *hazard* has therefore increased as a result of the way that it has been used (or misused). The risks from the hazard relate to a particular outcome, for example the risk of injury to a person from inhaling the spilled can of solvent or of a victim being burned if the material ignites. Other factors are also relevant to the magnitude of the risk e.g. the wearing of breathing apparatus or the presence of a source of ignition.

Let's consider some examples:

Exercise 1

At a party, the light bulb on the landing next to the toilet has blown. Rather than leave his guests in the dark, Joe decides to get out his rickety old step-ladder and change the bulb – even though he is rather the 'worse for wear' and the wiring in his flat is in need of repair

Which of the following might be the hazards and the risks associated with Joe's attempt to help his guests?

- The poor lighting conditions
- Getting an electric shock and as a result, Joe breaking his neck in falling off the ladder
- The faulty wiring system
- The ladder collapsing and Joe breaking his leg
- The loose rungs on the step-ladder
- The alcohol in Joe's bloodstream

- Breaking the light while trying to position the step-ladder

Exercise 2

Let's think about some topical issues that are often in the news. The person talking about this fictitious series of items in the bulletin is not really sure what the difference is between hazards and risks and sometimes gets them confused. Which of the following do you think is correct and which incorrect? By referring to the definitions and the example given above, can you give reasons?

- "A new report published today says that the risks of dying for people exposed to the new flu virus have been greatly exaggerated....."
- "Radioactive waste is a risk which is unacceptable because it can affect people for thousands of years and we do not have safe ways of storing it over the long timescales involved...."
- "A railway spokesman said that the risk of being killed in a train crash in the UK is significantly less than that of being killed whilst driving....."
- "The building is being temporarily closed while work is carried out to strip out asbestos from the ceilings. A spokesman for the company said that the asbestos was an unacceptable hazard..."
- "The AIDS virus was a risk that the world had failed to recognise during the 1980s according to experts at an international conference earlier today...."
- "Astronomers are concerned that a global catastrophe arising from the impact of meteorites in orbits which bring them close to the earth is a hazard that had not been fully recognised...."

2 COMPARING RISKS – LOOKING AT THE STATISTICS

We often want to compare the health and safety risks associated with different activities. It may be, for example, that we want to compare the risks of different occupations or we may be interested in the risks associated with everyday things we do in life. Making such comparisons is not as straightforward as it might appear at first sight and we have to be careful to make sure that we are comparing like with like.

By way of illustration, we will consider three situations where we need to be careful about interpretation of the numbers.

First, let's consider statistics about the number of people killed or injured in different jobs. The numbers are usually based on legal requirements to report accident data to the Health and Safety Executive (HSE). Even if the reports were 100% reliable (which in some industries they are not - particularly for reportable injuries), we need to think carefully about the statistics.

One consideration to take into account is that there may be a trend over time which is masked by the numbers. In the mining industry, for example, the risks of being killed in an accident were once very high in the UK. Nowadays, as a result of improvements in health and safety management and increased mechanisation, the risks are much lower. If we just looked at the number of deaths or injuries over the last 30 years and took the average, we may not be reflecting current risks very well at all. On the other hand, if we only look at statistics for the last few years, the numbers may be small and statistical variations from one year to the next could lead to misinterpretation. We also have to ask whether the statistics include those who are dying from diseases as a result of exposure to coal dust. Many years ago, when ventilation systems and personal protection would not meet modern standards, miners received much higher exposure to coal dust and other agents which many years later can cause cancer. We are now seeing the effects of this, although it does not reflect safety in the modern mining industry. It is sometimes also quite difficult to establish cause and effect ('causality') in some situations like this – particularly when there is a long period between exposure and its effects (as with coal dust, asbestos and radiation).

Another important question we need to consider is who exactly is included in the numbers – what are the statistics for those doing the most dangerous jobs? do the numbers refer only to those working below ground etc? So when we see figures like “the annual risk of death from working in UK coal mines is 1 in 10,000 per annum”, it could be that the risks of working in certain jobs is much higher and depending on the intended use for the data, we may want to ask about the basis for the figures in greater detail.

There are also other issues of which we need to be aware. For example, there are what are sometimes referred to as 'confounding variables'. One possibility is that the statistics hide the fact that different regions or different industries may have different ethnic, gender or age structures in the population or that people may have worked in other jobs which led to- or contributed to- their illness or chronic injury. These factors may potentially skew the numbers.

Similar types of consideration apply to 'everyday' statistics. For example, people often quote numbers relating to the risks of travelling by road, air or rail. Again, we need to think carefully about the numbers. Is it best to make comparisons on the basis of distance travelled or the number of journeys undertaken? Do the statistics for flying, for example, include only flights in commercial jet aircraft or do they include potentially more dangerous flying activities such as light aircraft, helicopters, military flying etc?

Comparing the risks of death in different industries can be even more difficult. We sometimes see numbers giving the risks of death arising from industries such as chemical or nuclear. Many of the questions raised above may need to be asked before they can be understood but, in addition, it is important to realise that in providing risk estimates in these cases, other assumptions have to be made. The ill-health effects of exposure to very low levels of radiation, for example, are usually based on properly cautious assumptions (the assumption, for example, that any dose of radiation leads to a risk of dying of cancer and that there is no threshold below which there is no effect even though we are all bathed in natural radiation from the earth and stars). This may lead to overestimates when we look at the results of exposure of millions of people to very low doses of radiation.

Furthermore, because there have been very few large scale accidents in these industries, estimates of the numbers of deaths to workers and the public are often based on engineering analysis using established techniques such as quantitative risk assessment or probabilistic risk assessment (QRA or PRA). This approach systematically sums up the probability of engineering systems failing to provide the protection that they were designed to give and successive lines of defence breaking down. It is then possible to estimate the chance of a particular outcome like an accident arising from a loss of coolant accident at a nuclear plant. Such estimates and the techniques used in deriving them can be very valuable, but the final numbers are only as good as our ability to predict all the potential accident sequences leading to the outcome being considered, including, for example, the intervention of people (either making things worse or better). The data used in QRA often rely on a degree of expert engineering judgement and it is customary to build in an element of caution in the numbers used to try to ensure that risks are not underestimated. Of course, this may not always be successful.

So there is an important message here – try to think critically about the assumptions that are being made when numbers are given. We may be not be comparing like with like! We often need to get beneath the headline statistics to really figure out what they are telling us.

Some statistics are given below which may be interesting and in some cases surprising. Although these are based on sources that are judged to be reliable, you may still want to ask questions about what exactly they mean and to apply them only when some of the above questions have been thought about in relation to them! The numbers given are approximate in some cases in order to make the associated exercise simpler. They are intended to be fit for purpose.

Table 1

Approximate annual risk of death in the UK for various age groups – based on deaths in 2004/5

<u>Population group</u>	<u>Risk as annual experience</u>	<u>Risk per million annually</u>
Entire population	1 in 103	9 660
Men aged 65-74	1 in 40	24 900
Women aged 65-74	1 in 63	15 770
Men aged 35-44	1 in 650	1 530
Women aged 35-44	1 in 1080	930
Men aged 15-24	1 in 1810	550
Women aged 15-24	1 in 4030	250

Table 2**Annual risk of death for various causes (entire population)**

Cause of death	Annual risk	Basis of estimate
Cancer	1 in 387	England and Wales, 1999
All accidents	1 in 4 060	UK, 2004/5
Road accidents	1 in 16 800	UK, 1999
Gas incident (fire, explosion or carbon monoxide poisoning)	1 in 1 510 000	GB, 1994-1999
Lightning	1 in 18 700 000	England and Wales, 1995-99

Table 3**Annual risk of death to employees in various industry sectors**

Industry sector	No. of deaths	Annual risk per 100 000 employees	Basis of estimate
Mining of coal and related jobs	1	11.4	GB, 2004/5
Construction	56	4.5	GB, 2004/5
Agriculture and related jobs	16	7.1	GB, 2004/5
Manufacturing	40	1.3	GB, 2004/5
Service industry	55	0.3	GB, 2004/5
All workers	220	0.7	GB, 2004/5

It is worth noting that in each of the examples above, the risk statistics have been presented in different ways. Data are often shown in different forms to draw out particular points. In the case of the data for occupational risks, for example, it is important to note the small number of fatalities on which the numbers are based. Since there was only one death in the mining and associated industries, the rate given is statistically a very unreliable number and may be subject to wide variability from year to year. This is an instance where averaging over longer periods may be appropriate so long as care is taken to allow for any trends over time (as discussed above). Also, injury rates are sometimes presented as a number per 100 000 hours worked by a group of workers. This number of hours represented a typical working lifetime, so the figures are intended to give an indication of the number of injuries of a defined type that the average worker might expect to receive in a working lifetime.

Table 4

Average annual risk of death from an activity

Activity	Risk	Basis of estimate
Pregnancy	1 in 8 200 pregnancies	UK, 1994-96
Surgical anaesthesia	1 in 100 000 operations	GB, 2006
Scuba diving	1 in 200 000 dives	UK, 2000-01,
Rock climbing	1 in 320 000 climbs	England and Wales, 1997-2000,
Canoeing	1 in 750 000 outings	UK, 1996-99,
Hang gliding	1 in 116 000 flights	England and Wales, 1997-2000,
Rail travel accidents	1 in 43 000 000 journeys	GB, 1996-99
Aircraft accidents	1 in 125 000 000 journeys	UK, 1991-2000

By comparison, the average probability of winning the jackpot in the National Lottery with a single lottery ticket has been quoted as being about 1 in 14 000 000.

Exercise 1

You are a keen lottery player and travel 5 miles every week in your car to the nearest town to buy your ticket. Based on some reasonable assumptions and the above statistics, are you more likely to win the lottery that week or be killed on your journeys by car that year? What assumptions have you had to make and how reasonable are they in reality?

[The average motorist in the UK drives about 12 000 miles each year. From the above figures, this has an associated risk of being killed of about 1 in 16 800. So if you drive 10 miles (there and back) 50 times a year, you will have driven in total 500 miles (a 24th of the annual average). Thus you will have run a risk of about 1 in (16 800 x 24) or about 1 in 400 000 of dying in a road accident as a result of your journeys. You are thus about 35 times more likely to end your life than to live in luxury for the rest of it - although the chances of dying or winning are both pretty low!]

Exercise 3

As a result of the activities that the young engineers have been involved in associated with their visit to the oil platform, they discuss the risks associated with this as well as some other risks they might have been running if they had been doing other things. One view is that the flying is the riskiest thing they have done; another of them takes the view that spending a week on an oil rig or on a construction site is much riskier. Of course, had they not been doing the project they would all have been driving to the station and taking the train to the office and working there each day. One of them had planned to be on leave and do scuba diving. She wonders whether her risk profile had improved or got worse through being at work. What do you think based on the tables above, the additional information presented below and by making some reasonable assumptions? What are the most important assumptions you had to make? When you have done your estimates, 'drag' the activities as listed below into descending order of risk based on your sums.

- A return flight from London to Aberdeen with a commercial airline
- A return helicopter flight from Aberdeen to the oil platform – assume this takes half an hour in total. (the fatal accident rate for North Sea helicopter operations is about 0.13 per 100 000 hours flown)
- Working on the oil platform in the North Sea for 5 days (from 2002/3 to 2004/5, the fatal injury rate, based on the 20 000 or so workers, was about 3.7 per 100 000 workers)
- Working on a construction site for the five days
- Driving 250 miles, in total, during the week (about the UK average)
- Doing ten train journeys to and from home and the office over the period.
- Doing ten scuba dives whilst on leave during the weeks' leave that might have been taken.

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3. HOW PEOPLE VIEW RISKS

We have seen some of the statistics relating to risks. You may have been surprised by some of them: for example, by the fact that it is so much safer to travel by train or plane than to drive. However, many people are genuinely frightened of flying and following several railway accidents in the UK a few years ago, some people have reservations about rail travel. Our views are even more diverse when we consider the risks of some technologies - as we will discuss further below.

We are surrounded by hazards, all with the potential to lead to unwanted consequences. Some of the risks we face arise from natural hazards, some from technological developments, whilst others arise from our lifestyle. How we deal with these is often a question of personal choice. Some of the risks that are imposed upon us by others sometimes seem to be minor when scientifically analysed but they nonetheless produce a massive public reaction.. Others, which appear more serious when assessed, are often largely ignored. It is interesting to try to understand how different risks are perceived, but there is a key message for us as engineers - that it is important that we understand that whatever the science seems to tell us about the size of a risk, it is people's perceptions of it that will determine whether the risk is deemed acceptable to society.

Social scientists have been trying to understand what it is that shapes attitudes and responses to various types of risk. The subject is complex and a large volume of scientific literature now exists. We can only touch on some of the issues here.

Risks are often taken to secure a benefit – like driving to see friends or flying to go on holiday – and we all probably consciously or unconsciously balance the benefits and disbenefits of taking a particular course of action. Whether we give it much thought, will probably depend upon whether the risk has a high public profile or has affected us or somebody we know. Our attitude will also be strongly conditioned by our personal attitude to risk generally – are we risk averse or do we like to take risks?

But what shapes attitudes to technological or other externally imposed risks? Below, we have listed some recent risk issues that have attracted public attention and on which people sometimes hold strong views. As a result, in some cases, action has been taken to try to avoid the risk altogether or to control it by legal and/or regulatory processes. In other cases, the debate goes on as society tries to decide on the best course of action.

TWENTY RECENT ISSUES OVER WHICH THERE HAS BEEN PUBLIC CONCERN:

- **Global warming**
- **The use of the triple vaccine (MMR)**
- **The use of nanotechnology**
- **Disposal of radioactive waste**
- **Genetic engineering in humans and animals**
- **Proliferation of handguns**
- **Disposal of offshore oil rigs**
- **Nuclear power plant**
- **Train and plane crashes**
- **Genetically modified foodstuffs**

- Electromagnetic fields from mobile phones
- Smoking cannabis
- Smoking in public places
- Exposure to “mad cow “ disease (CJD)
- Over-consumption of alcohol
- Impact of large meteorites on the earth
- Exposure to superbugs in hospitals (such as MRSA)
- Chemical additives in food and water
- Fire and gas safety in buildings
- Mutation of viruses leading to untreatable epidemics

EXERCISE 1

Many of these issues will involve input from engineers and scientists as part of the decision making process. Can you think of any others that concern you or your friends and family?

Against each one on the list (including any that you add), give your own personal ranking of the importance of the risk that the issue presents. A ranking of 1, means “it is not of much concern to me”, whilst a ranking of 5 means that “I think this risk is really important and we ought to be doing more about it”

The list above largely contains issues which are referred to as ‘societal concerns’. These are issues which have an impact on society as a whole and on which decisions need to be taken collectively (but which may nonetheless affect us as individuals). Let’s now think about the sort of factors, quite apart from statistics or scientific analysis, that make people regard these types of risk issue as important or not so important. What was it that influenced us most in giving our rating of 1 to 5 in the exercise above?

We all put a different emphasis on the ten factors listed below, but they are some of the things which have been identified as contributing to our perception of risks:

1. How much do we trust those who are providing information about the risks and exercising control?
2. How certain are we about the consequences?
3. Is it a new risk of which we have little experience?
4. Are the effects likely to be immediately observable or are the consequences delayed and possibly insidious?
5. Is it likely to give rise to disasters involving multiple victims (all at the same time)?
6. How easily can it be controlled?
7. Does it have the possibility of being globally catastrophic?
8. Are the consequences “dreaded”? (e.g. it may cause cancer or genetic damage to future generations)
9. Is it imposed on us and do we have much personal control over the risk?
10. How much benefit do we get from the source of the risk? Are those running the risk getting a direct benefit?

Let’s now look at three items from the above list of issues and consider which of the ten factors might apply – the more stars (up to three), the more the factor led people to be concerned! (This is the author’s personal view of why people perceive the risk the way they do – the nature of the subject is that you may see it quite differently!)

1 Radioactive waste disposal	2 Train disasters	3 Impact of meteorites
1 **	1 *	1 -
2 ***	2 *	2 *
3 **	3 -	3 *
4 ***	4 -	4 -
5 **	5 ***	5 ***
6 ***	6 **	6 ***
7 **	7 -	7 ***
8 ***	8 -	8 *
9 ***	9 ***	9 ***
10 ***	10 -	10 ***

Each of these risks has a different “profile” of issues which might have influenced our perception of them. However, each of them has been a matter of public concern despite scientific analyses which suggest that the risks we run from them is really quite small compared with other risks about which people tend to be much less concerned - like driving or crossing the road.

EXERCISE 2

Choose three of the other issues from the twenty listed above (or from any which you added) and think about the influence of the ten factors identified above on the way that people perceive the risk. Do you think that there are any other factors which have not been considered above? Try to rank the importance of each of the factors identified using 0-3 stars as was done in the above example.

What does all of this mean for us as engineers?

Firstly, it is vital that we make our best scientific assessment of the risks involved in a technological decision, being honest about the uncertainties in our analysis. As we have seen this is not likely to be the only factor which affects decisions and people’s views, but it is an important input

Secondly, we need to think about how we can communicate the issues in a way that will be based on our engineering judgement but which recognises that people will need to trust what we are saying. This will depend, at least in part, on whether we can show that we recognise and are trying to address their legitimate concerns and interests.

Finally, the above discussion should have made it clear that the way people treat and respond to risks is complex. We need to be conscious of the influences and to address these when we make decisions which have a potential impact on others.

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APPENDIX 3

A typical page of script

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Screen C1 – Hazard vs. risk

Frame	Actions	Graphic	Screen content	Destination
C1.1	Display text and images Display section title throughout - <i>Hazard vs. risk</i>	Montage of hazards Chemicals in barrels Scaffold Pylon Tool in use	<p>What is the difference between a hazard and a risk?</p> <p>The terms ‘hazard’ and ‘risk’ are used interchangeably in everyday use. Nevertheless, they have quite different meanings and we need to be aware of this difference.</p> <p>Put at its simplest, a hazard is something that can cause harm (e.g. chemicals, an object on a scaffold which might fall on somebody, high voltage electricity, a mechanical tool).</p> <p>Risk is the chance (big or small) of harm actually being done.</p>	<sub-menu C >C1.2
C1.2	Replace text and overlay image with HSE logo	HSE logo	<p>What is the difference between a hazard and a risk?</p> <p>The Health and Safety Executive define (more formally) a hazard as, “...the potential for harm arising from an intrinsic property or disposition of something to cause detriment”. Thus a hazard is a state of the world or a state of affairs that could result in harm. It is the way the world is at a point in time. A hazard may be in the past, present or future.</p> <p>The HSE define risk, “...as the chance that someone or something that is valued will be adversely affected in the stipulated way by the hazard.” Thus risk is the chance of something occurring in the future, combined with the consequences that might flow from a hazard, set in a defined context.</p> <p>A ‘risk’ depends upon three factors – a defined consequence of the hazard (death, serious injury etc), the chance that this will occur and the context of the risk. For example, the risk associated with an industrial hazard would be regarded differently to that associated with a leisure activity even if the consequences and chance of occurrence were the same.</p>	>C1.3a

APPENDIX 4

Proposed draft list of hazards (with associated commentary) for the construction site simulation

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Virtual construction site – hazards

In this activity, we will see just some of the hazards that might be encountered on a construction site. In addition to pointing out the hazard and giving an indication of potential consequences and associated statistics, we will also mention some requirements and good practices. These are not intended to be in any way comprehensive. We will give links to some very helpful HSE and other websites but if you ever have to take professional responsibility for health and safety matters (beyond the responsibility that we all have to ourselves and others), it is vital that you know the actual up-to-date legal requirements or receive advice from someone who does.

Activity	Hazard
Movement around site	Generator connected to pneumatic drill with cables running across a walkway. This will be a jumble of cables that run across the floor in a clear pedestrian thoroughfare.
	These cables constitute a tripping hazard and they have been placed across a walkway. It's good that there is a clearly marked pedestrian route but such areas should then be kept clear of obstructions. If there is no alternative for a short time to run a cable across such a route, for example to carry out an urgent repair, the route should be diverted or if this is not practicable, the obstruction clearly brought to the attention of those who could be affected. Slipping and tripping are the most common kind of major injury. In 2004/5, nearly 11000 major injuries were caused in this way – constituting over one third of all major injuries.
	The majority of cables on site will be yellow (indicating 110V). Some will be black (indicating 240V) which is incorrect and a potential hazard. To make identification easier, the cables may be labelled.

Activity	Hazard
	<p>There are incorrect colour codes on the electrical cables. It is good that portable tools are being run at low voltage from a transformer because normal mains voltage can kill and a reduced voltage is much less hazardous. However, the low voltage cables should all be yellow and not a mixture of colours and the 230V cables should generally be blue (sometimes black sheath cables are used as well).</p> <p>There are several major hazards arising from electricity. The most obvious is contact (either direct or indirect) with live parts leading to electric shock or burns due to the passage of current through the body. Other hazards include inadvertent contact with overhead power lines and underground cables, initiation of fires and explosions caused by electrical apparatus or static electricity igniting flammable vapours or dusts and the lack of secure isolation. It is important that circuits are not capable of being made, or live machinery started, while they are being worked on..</p> <p>Although it is clearly safer to work with a lower voltage, there is no prohibition on the use of 230 Volts on construction sites, provided that appropriate safety measures are taken including physical protection, use of residual current devices (RCDs - also sometimes called circuit breakers), safe routing of cables, inspection and testing and proper maintenance.</p>
	<p>Poor housekeeping with piles of rubbish on floor.</p> <p>It is often said that the simplest way to assess the safety of a workplace is to look at the 'housekeeping'. If a site or factory has piles of rubbish or litter around – it usually reflects the general lack of interest of management and the workforce in maintaining safety!</p> <p>Whilst some safely stored, discarded material is acceptable for a time, large quantities represent a hazard, particularly where people are likely to be walking. Poor housekeeping can lead not only to a tripping hazard, but also increase the risk of fire – particularly in enclosed spaces, like the shop floor of a factory.</p>
	<p>Scaffold tubes across thoroughfares.</p>

Activity	Hazard
	<p>This is another case of obstructing the areas where people will be walking, thus causing a tripping hazard with the potential consequences discussed earlier when we saw the cables across the walkway. It is also a further example of poor housekeeping. Equipment like scaffold tubes should be stored in dedicated areas and in such a way that they can be safely moved to the point of use.</p> <hr/> <p>Scaffold boards in inappropriate places</p> <hr/> <p>This is yet another case of bad housekeeping with the potential for tripping etc.</p> <hr/> <p>Correctly partitioned site with dedicated walkways for pedestrians to separate them from vehicles. However on several parts of the walkway obstructions prevent safe passage (see above).</p>
	<p>In addition to the need to ensure that walkways are kept clear of obstructions, it is vital that areas where people move across the site or work are separated where practical from vehicles. Drivers need to be trained but they also need to be given help to be able to see people clearly, so high visibility clothing should be worn on site. Audible alarms, flashing lights and supervision of vehicle movements (particularly when reversing or near blind corners) are required.</p> <p>In 2004/5, about one sixth of all workplace fatalities occurred as a result of a person being struck by a moving vehicle.</p>
Use of PPE	One or two workers or visitors/managers (men in suits) not wearing hard hats on site

Activity	Hazard
	<p>Even when engineering controls and safe systems of work have been applied, some hazards remain. These include injuries to the head and feet (e.g. from falling materials); the eyes (e.g. from flying particles or splashes of corrosive liquids); ears (from loud noise) and the skin (e.g. from contact with corrosive materials). Personal protective equipment (PPE), such as safety helmets, goggles, gloves, ear defenders and safety shoes, is needed in such situations and it is a legal requirement that they must be provided free by the employer.</p> <p>Requirements should be made clear to all those coming on to the site as part of the safety brief and there should be signs and reminders around the site. People should not be allowed to work or visit areas which have been designated as requiring specified PPE until they are wearing it. Training in its use and its limitations should be given.</p> <p>On most construction sites, the whole of the site is normally designated as requiring the use of safety helmets, suitable foot protection and high visibility clothing. In other workplaces, areas are clearly marked (e.g. with a yellow line or series of notices), such that people are fully aware of the requirements.</p> <p>Sometimes, managers and more senior staff (such as these men in grey suits!) are the worse culprits because they think that they won't be in the hazardous area for long or do not have their PPE handy. This is not acceptable because they should be setting an example. Remember: the highest standards you can expect from others are the lowest that you set yourself!</p> <p>Someone using a pneumatic drill with no eye, ear or foot protection. This will need to be very obvious so we are proposing to have the worker wearing an I-pod and flip-flops (this does happen!)</p> <p>Again, the worker here is not using his PPE. In a job such as the use of a pneumatic drill, head, eye, foot and ear protection should be worn..</p>
Storage	In the storage area, some unmarked oil drums with no catch trays and a leak.

Activity	Hazard
	<p>Leaking oil is both a safety and an environmental hazard. The leak of oil could lead to a slipping or fire hazard and will be difficult to clear up. In addition, it is an offence under environmental law for substances such as oil to be allowed to get into drainage systems etc. Furthermore, all containers containing oil, chemicals or similar materials should be clearly marked (and any dangerous materials securely stored). In this case there is not only a leak that could be avoided by the use of a catch tray but the drum is not marked as containing oil – either clean or dirty.</p>
<p>Working at height</p>	<p>In the new building area, high scaffold platforms with no guard rails and toe boards.</p> <p>Scaffolds in the form of mobile towers and more permanent structures, lead to many injuries both to those working on them and to those close by who may be injured by falling objects or failure of the scaffold.</p> <p>In this case, the law is being broken because a platform more than 2m from the ground, must have guard rails and toe-boards. The minimum size for these is specified in law.</p> <p>Other things to remember about fixed scaffolds are that they must be erected, altered or dismantled by competent people and inspected at least every week or after bad weather with a formal record kept; they must be based on a firm foundation with plates at the base of the vertical supports which should normally be not more than 2 to 2.5m apart; should have platforms which are wide enough to work on; have safe ladder access and have boards properly supported without excessive overhang, It is also vital to prevent material falling from scaffolds by suitably enclosing them..</p> <p>Similar (but not identical) requirements apply to mobile tower scaffolds.</p> <p>Falls from height – an injury reporting category which includes falls from scaffolds, ladders, roofs and platforms – led to 53 deaths and nearly 4000 major injuries in 2004/5.</p> <p>Scaffold is not erected using footplates and soleplates in some places.</p>

Activity	Hazard
	<p>This shows missing footplates and sole plates at the base of the vertical supports. As discussed previously, these are required by law to minimise the risk of the scaffold becoming unstable and the potential for collapse</p>
	<p>An unsecured ladder at a shallow angle</p> <p>We all think we are familiar with ladders but a large number of accidents occur in the workplace and at home from faults and from inappropriate use. In this case the hazard is presented by a ladder which is at an angle to the wall that is too shallow. Ladders should be angled so that the bottom will not slip outwards – four units up to each one out from the base is a good rule of thumb.</p> <p>Other things to remember about ladders, include fixing and tying them (all ladders of more than 6m must be fixed and tied); ensuring that they are in good condition (e.g. no cracked or missing rungs and never use a painted ladder because this could hide defects); ensuring secure footings and top placements and making sure that there is an overlap between the halves of at least three rungs on an extending ladder.</p> <p>.</p>
	<p>Someone is working from the top rung of a step ladder and reaching across to something</p> <p>In addition to making sure that the ladder itself is safe, it is important to ensure that it is used safely. For example, the user should not stand to work within 1m of the top, not carry heavy or long items up the ladder and not overreach.</p> <p>Here we have examples of two poor practices in the use of a ladder. The worker is far too close to the top and is overreaching.</p>
	<p>Person using a cutting torch attached to propane bottle on a scaffold without edge guards. The bottle is on its side and could easily roll off the scaffold, risking harm to those beneath and potentially dragging the worker down with it.</p>

Activity	Hazard
	<p>There are two issues exposed here. First, it is unsafe to work with the propane gas bottle on its side because it is unstable in this configuration and may roll causing danger from the cylinder itself, but also it could lead to the connection to the line being lost with the release of pressurised propane gas. Gas bottles should always be stored in the vertical position and secured so that they cannot topple over. The hazard is even greater in the case shown because it is being used on a scaffold without edge guards. There is a real danger that the gas bottle could roll off the scaffold and have serious consequences for those below. It is also possible that the person using the torch might be dragged down with it!</p> <p>Cherry picker – person working within who is not wearing a harness or attached to the safety line.</p> <p>In this case, the worker is using what is known as a ‘cherry picker’ to carry out work at height. In principle, this is an acceptable way of carrying out such an operation since it provides a secure working platform (but only as long as all other requirements have been met regarding, for example, the safety of the device and the training of the user). However he is not attached to any anchoring device to stop him falling from the working platform. Anyone working who might fall while working at height is required to wear a safety harness (and other devices such as fall arresters in certain circumstances). The requirements are specified in detail in the relevant regulations.</p> <p>It has already been noted that falls from height are one of the major causes of death in the workplace, accounting for nearly a quarter of all such deaths.</p>
	<p>Milk crate being used to provide an extra foot of height to someone working on the outside of the building.</p>
	<p>It is very tempting to use whatever comes to hand to get those few extra inches of height when doing a job that is just beyond our reach, rather than having to make the effort to go and get a pair of stepladders. It can be a costly decision however. Standing on any unstable object is dangerous and the convenient milk crate being used here is not acceptable.</p>
	<p>Netting slung on pre-fabricated building showing clear signs of bulging where it has prevented a previous fall (netting should be renewed after all such incidents).</p>

Activity	Hazard
	<p>It is good to see that netting is being used to catch any falling objects that might hit someone below – but look carefully and you’ll see that it is bulging. This almost certainly means that it has already served its purpose! However its integrity may have been affected in the process and the bulging is a good indication of this. It should have been replaced.</p>
Excavation	<p>Men working in a deep trench without the sides sloping or being supported.</p> <p>Ground work presents a range of hazards. In this case, men are working in a deep trench which could collapse and bury them. It is a requirement that any excavation deeper than 1.2m must have the sides sloped or adequately supported.</p> <p>Another major hazard in work of this type arises from buried services such as electricity cables. It is vital that work takes place away from areas where these might be located or if there is any doubt, that detection devices are used. There are a significant number of cases each year where workers are killed or injured as a result of drilling into cables.</p>
Lifting operations	<p>Stacking materials in an unsafe way – pile of breeze blocks with a broken pallet causing the stack to lean. Potentially include some blocks that have fallen to the floor.</p>

Activity	Hazard
	<p>There are two types of hazard here. First, the breeze blocks are being stacked in such a way that they could fall and cause injury with the specific hazard caused by the broken pallet. Second, the workers are not lifting the breeze blocks safely. They should be keeping their backs straight, keeping their bodies close to the load, avoiding twisting, placing their feet apart with the leading leg forward and using their legs rather than backs to do the work..</p> <p>Stacking objects safely is important since the collapse of a stack of heavy objects can cause very serious injury to those working in the vicinity or even those passing by. Generally, heavy items should be stacked so that they are near ground level.</p> <p>There were over 50 000 injuries from handling, lifting or carrying leading to absence from work for more than three days in 2004/5. Damage to backs and other so-called musculoskeletal injuries are one of the two greatest causes of occupational ill-health (the other being stress) and the pain and lost output resulting from this cause is enormous. All workers should be trained in safe lifting and handling techniques, lifting operations should be planned and the use of mechanical devices considered to minimise manual handling. There are again specific regulations on this subject</p>
Workplace transportation	Vehicle ignoring the one-way system on site and reversing around a blind corner without a banksman (and potentially without warning siren)
	<p>Reversing round a blind corner (against the one-way system!) is hazardous for both pedestrians and other drivers. The workplace should be designed so that pedestrians are safe from vehicles with the two separated as much as possible as we discussed earlier. In this case, the driver needs to be able to see clearly and if this is difficult, he needs the help of a ‘banksman’ – someone helping him with the manoeuvre and warning others in the area. Vehicles moving in such situations should also use audible alarms and other warning signals such as flashing lights and pedestrians need to be wearing high visibility clothing. It is not only trucks that present a hazard but vehicles such as fork lift trucks.</p> <p>Being struck by a moving vehicle is the second highest cause of death in the workplace (after falls from height) and led to 35 fatalities in 2004/5.</p>

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