



# **Development of an IIG/HSE e-learning health and safety risk education package for engineering undergraduates**

Prepared by **RHT Risk Management**  
for the Health and Safety Executive 2006

## **RESEARCH REPORT 452**



# **Development of an IIG/HSE e-learning health and safety risk education package for engineering undergraduates**

**Professor Richard Taylor**  
RHT Risk Management  
33 Dennyview Road  
Abbots Leigh  
Bristol BS8 3RD

**David Bell & Vincent Smyth**  
Logica CMG  
Hamilton House  
Church Street  
Altrincham  
Cheshire WA14 4DZ

This report describes work coordinated by the author, with substantial input from Logica CMG, to develop outline proposals to “proof of concept” stage for an e-learning package to teach undergraduate engineers of all disciplines, key concepts relating to health and safety risks. It is based on outline teaching material developed previously by a sub-group of the Inter-institutional Group on Health, Safety and Risk, chaired by the author.

Three “layers” of material are proposed. The first is a simulation 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” would consist of briefing material, interactive exercises and assessments. The third “layer”, would be accessible from the package of material proposed, but would be populated by university departments to meet their specific needs.

The proposals have been presented to a wide range of stakeholders, including Engineering Institutions, Universities and the Higher Education Academy (HEA) Engineering Subject Centre, the Engineering Council (UK), the Engineering Professors’ Council and three industrial companies. The approach has received broad support, with useful feedback to inform a further phase of development. It is recommended that this should involve the production of a representative sample of the proposed material for further discussion with potential funding organisations and others and to resolve outstanding issues.

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.

© Crown copyright 2006

*First published 2006*

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the prior written permission of the copyright owner.

Applications for reproduction should be made in writing to:  
Licensing Division, Her Majesty's Stationery Office,  
St Clements House, 2-16 Colegate, Norwich NR3 1BQ  
or by e-mail to [hmsolicensing@cabinet-office.x.gsi.gov.uk](mailto:hmsolicensing@cabinet-office.x.gsi.gov.uk)

**Copyright note:**

Figure 3 in this report is, as shown, reprinted with permission from The American Association for the Advancement of Science (AAAS), 1200 New York Avenue, NW Washington, DC 20005, USA. Readers may view, browse and/or download this material for temporary copying purposes only, provided these uses are for non commercial personal purposes. Except as provided by law, this material may not be further reproduced, distributed, transmitted, modified, adapted, performed, displayed, published, or sold in whole or in part, without prior written permission from the publisher.

# CONTENTS

## Executive summary

1	Introduction and background to the project	1
2	Scope of the project	2
3	Initial work with Logica CMG and the project definition	4
4	Development of the e-learning package	6
4.1	Introduction to the material	6
4.2	Oil Rig Delta-Tango	7
4.3	Construction Site	9
4.4	Local Community “swamp buster”	9
4.5	Learning from a major accident	10
4.6	Concluding section of package	10
5	Cost estimates and IT Issues	11
6	Stakeholder feedback on outline proposal	12
6.1	Identified stakeholders	12
6.2	Organisations approached	13
6.3	Feedback received	13
7	Issues for further consideration	15
7.1	Use by Engineering Institutions for accreditation purposes	15
7.2	Publicity and feedback from the academic community	15
7.3	Continued support to users	16
7.4	Production of briefing material and assessment material	16
7.5	IT Issues	16
7.6	Costs	16
7.7	Timescales	17
7.8	Funding	17
7.9	Other Issues	17
8	Conclusions and recommendations	18
9.	References	20
	Appendix 1 – Summary paper of H & S issues	22
	Appendix 2 – Summary notes of meetings with stakeholders	25



## EXECUTIVE SUMMARY

This report describes recent work coordinated by the author, with a major input from Logica CMG, aimed at developing an e-learning package to “proof of concept” stage for teaching undergraduate engineers of all disciplines about key concepts relating to health and safety risk. The work was sponsored and funded by the HSE, but builds on an earlier phase of work carried out under the auspices of the Inter-institutional Group on Health, Safety and Risk (IIG). The IIG has continued to support the current phase of work.

An outline approach has been produced which involves three “layers” of teaching material. The first layer would be in the form of a series of interactive simulations, similar to a video game. These would be based on questions and issues raised by a team of three young graduate engineers involved in four projects as part of their training programme with a major company. Following introductory material, which would aim to explain and draw out the importance of the subject and raise awareness and interest (for example by using video material of disasters and the personal impact of these together with the impact of industrial accidents or individuals), the team would embark on a simulated “journey” involving the four projects.

As examples, the first part of this might involve the team flying to an oil rig in the North Sea where they would help to undertake safety assessments. The second project could involve their assistance in identifying and remediating health and safety risks on a newly acquired construction site. In the third part of the “journey”, the team might be “loaned” to help a community in a developing country develop a vehicle to travel across swamp land. Finally, they might help to investigate a complex, major, “organisational” accident at one of the company’s sites, thus introducing issues relating to organisation for safety, learning and safety culture.

In each of these video simulations, the team encounter health and safety issues, debate them and as a result, questions and issues are raised for the student to think about and address. The second “layer”, would provide the student with short briefings, together with interactive self-assessment material to help them to arrive at conclusions and to learn some practical skills. A third “layer” is also proposed which would be accessed from the first two, but would not generally be populated as part of this project. It would be available to universities to add material relevant to their specific needs. The package would be designed to be modular and used in the form of a “toolkit” which university departments could use to support project work and other course work, rather than as a specific extra part of the curriculum.

The outline and proposed approach has been discussed with a wide range of stakeholders, including the IIG, Engineering Council (UK), Higher Education Academy (HEA) Engineering Subject Centre, three university departments (including students) and the Engineering Professors’ Council. It has also been discussed with several major industrial companies. In all cases, the overall response has been positive, particularly to the idea of a modular, layered structure and the use of a strongly interactive approach. Useful advice and feedback has been obtained which will inform any future phase of the work. Logica CMG has given an indication of potential costs for video simulations.

The main further conclusions of the current study are, firstly, that means must be found to support and promote the material after it has been developed. With suitable funding, the HEA Subject Centre could have an important role to play in this. The second (and main recommendation) is that a demonstration module should now be produced. This might be based on a simulated construction site. The “sample” could be used to raise general issues in relation to such matters as relative risks and the perception of risk, but could also be used to provide examples of some of the practical skills, which might be developed, such as identifying workplace hazards and carrying out risk assessments. Such a trial would enable greater certainty to be developed about costs and some identified logistical issues but, it is suggested, would also be an excellent vehicle with which to seek funding for the development of a full package.

## 1. INTRODUCTION AND BACKGROUND TO THE PROJECT

The Inter-institutional Group on Health, Safety and Risk (comprising representatives of the expert groups and secretariats of the Institute of Electrical Engineers (IEE), I Mech E, Institute of Civil Engineers (ICE), Institute of Chemical Engineers (I Chem E), Hazards Forum and Ergonomics Society) 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, particularly in the context of health and safety. Initial work considered learning outcomes and identified source material and this was followed up by the production of a document by a sub-group involving academics, HSE and other experts, which summarised the range of topics which might be included in teaching material<sup>1</sup>. The intention was that the material would be applicable to all engineering students irrespective of their specific engineering discipline.

These documents received strong support from the Engineering Institutions, the HSE, and the Engineering Council (UK) (who saw it as a 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.

Last year, this project moved to a second phase with financial support from the HSE, with the IIG Sub-group continuing 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 as a contribution to meeting related objectives in its strategic document “Revitalising Health and Safety”<sup>2</sup>. The intention of this phase has been 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 has proceeded with continued input from several of the above stakeholders, but has also benefited from the strong involvement of a company (Logica CMG 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 is that a novel e-learning package has been developed in concept, which incorporates nearly all of the identified teaching material in a way which is likely to appeal to the end users. The approach has been presented to a wide range of stakeholders in order to obtain comments and input. This could then be used to refine the material and to gain further support. The intention is to move to a further phase next year where all (or part of the package on a trial basis) would be produced and the content developed in detail, again working with experts and end-users. This report describes the most recent work carried out, the conclusions reached, and makes recommendations on next steps.

## 2. SCOPE OF THE PROJECT

In December 2003, the IIG subgroup produced a paper entitled “Outline of Proposed Undergraduate Engineers’ Teaching Material on Managing Risks following work by the IIG and HSE”<sup>3</sup>. This identified the issues, which were felt to form the basis of an undergraduate teaching package on health, safety and risk. It is a fairly detailed document and, as a precursor to the current phase of the project, it was thought useful to provide a short summary of the context of the IIG document. This is attached as Appendix 1.

The note contains eight sections. The first section proposes that some hard-hitting messages be included to explain why the subject is important. This might be achieved, for example, by reminding students of the consequences when things go wrong. Disasters such as Piper Alpha, the Challenger and Columbia space shuttles, recent UK railway accidents etc. can all be used to highlight the vital role of engineers. Accidents involving personal injury or death are much more common, however, and personal accounts from those involved in-, or affected by-, such accidents may also provide an opportunity to gain the attention and commitment of students.

The second area, “Risks in Perspective”, aims to give students an understanding of terms such as risk and hazard and to provide a perspective on the actual risks involved in a variety of activities and occupations. However, it also aims to address the issue of why perception of risk is often very different from the statistics. In doing this, the importance of ‘systems’ thinking can be introduced, and the need to understand such issues from the point of view of a wide range of stakeholders.

Introducing issues in health and safety is sometimes done by looking at the legal requirements. This was not seen to be a good way of engaging the interest of engineering students, but it was felt that some broad concepts relating to the regulation of health and safety might be covered. This would be aimed at highlighting our personal responsibilities and could also introduce issues relating to ethical and professional requirements and how these can be addressed.

The costs of accidents and ill –health are frequently underestimated. Section 4 proposes that this issue be addressed in terms of personal and business costs. It includes the need to learn from near misses and to treat these as ‘free lessons’. In discussing costs, there is also an opportunity to develop an understanding that absolute safety cannot be achieved and that benefits and costs need to be balanced when making practical decisions.

Section 5, dealing with “Engineering Issues”, covers a range of important concerns for the engineer. It is intended to illustrate the importance of good management systems and procedures, the need to consider risks holistically (from cradle to grave in a project, for example) and to understand the importance of allowing for the human factor.

Section 7 is related to section 5 and provides an opportunity for the student to understand practical issues relating to health and safety. An example of this would be an introduction to the type of hazards, which might be encountered in the workplace and how these risks are managed and controlled. One practical learning outcome may be the ability to understand the importance of carrying out risk assessments, and to be able to carry one out in a simple but realistic situation.

The concept of safety culture (section 6) is sometimes regarded as too difficult for a student to grasp. However, the use of practical examples of how people-related issues can affect engineering outcomes can be used to illustrate the points being made. Most importantly, it is intended to convey the message that, as individuals, our behaviours and approach to leadership, communication and learning is vitally important. Failures occur not simply through inadequate engineering, but frequently through complex interrelationships between plant, processes and people. The IIG subgroup was strongly of the view that issues of this type need to be introduced at an early stage in engineering training.

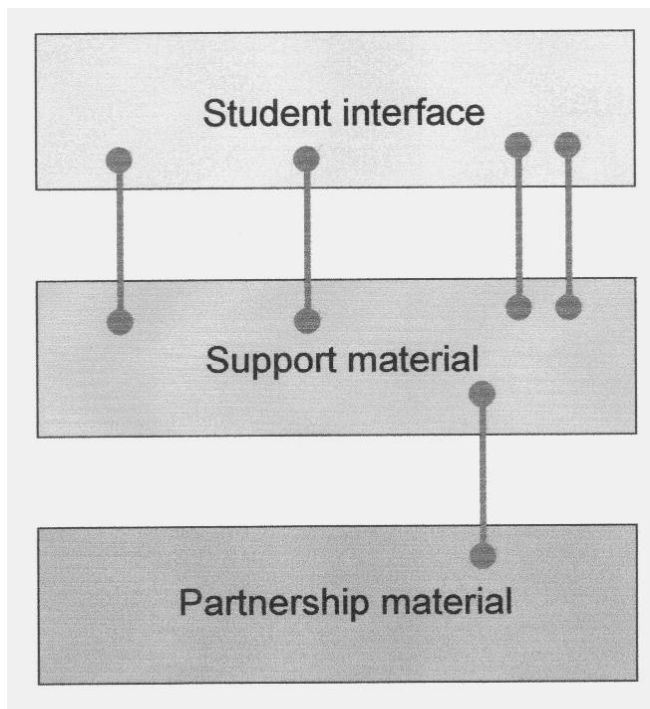
The IIG subgroup paper and the summary above (Appendix 1) provided the basis for discussions with the consultants (Logica CMG). These consultants were retained by the HSE to advise on how an e-learning package could be developed. This was thought to be a good way of introducing the above concepts effectively but also in a form which might strongly engage student engineers.

### 3. INITIAL WORK WITH LOGICA CMG AND THE PROJECT DEFINITION

The initial meeting with Logica CMG took place on August 2nd, 2005. They were provided with the background to the work to date and five principles were agreed for the current phase:

- a) The primary vehicle for involving the student should be built around the concepts employed by Logica CMG in previous e-learning projects which they had undertaken for various clients. These are highly interactive, using simulations and video-gaming techniques, which involve the student.
- b) The package of material to be developed in outline, should not be concerned with engineering detail, but should be sufficiently broad to be of interest to all engineering disciplines. However, it should be designed to be thought provoking with the students having to make their own decisions. It should aim to address possibly unfamiliar concepts in a way both which develops an understanding of them, as well as providing, related practical skills. It should be challenging to capable students but not too daunting for less able students.
- c) A series of simulated scenarios should be developed which would be of interest to the student. Each of these would be designed to cover specific areas of the teaching material identified by the IIG subgroup.
- d) The package of material should not be primarily designed to be taught as a formal course requirement but kept flexible so that it can be used on a modular basis to deal with issues as required by the users. For example, if students undertake a project, the package should be designed as far as possible to support the specific needs arising from this.
- e) The presentation of the material should be in three parts or 'layers'. This is illustrated in Figure 1. The 'simulations' (student interface) would form the first layer. Based on the previous work of Logica CMG, these could include a variety of elements including 'placing' the students in an environment in which they would observe and be asked to respond to various situations, and to simulate interactions with people and processes. The second 'layer' (support material) would comprise briefing material and self-assessments which relate to the issues raised in the simulations. The third 'layer' (partnership material) would be available to universities and other potential users of the package, but would not generally be populated as part of the proposed project. This could contain material specific to the interests of the user, including greater detail on specific issues or material relevant to the specific engineering discipline or to a project being undertaken by the students. The structure of the package should make it simple for such material to be added and accessed by users.

Figure 1



In order to allow the Logica CMG participants in the project to gain a fuller understanding of the concepts and issues to be taught, two further meetings were held at which they were briefed on the proposed content. In order to achieve this, a series of references were identified and discussed. They have been retained as source material for future use.

## **4. DEVELOPMENT OF THE E-LEARNING PACKAGE**

The core of the proposed e-learning package is based on a simulation of the activities of three newly- recruited graduate engineers working as a team for a major international company. It is intended that students using the e-learning material identify with these young engineers and are invited to enter into debates, which take place between the young engineers as part of simulated material. The team members, as an extension of their emerging personalities, develop different views about the issues and the student user effectively participates in the debate and has to arrive at 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 involve a virtual “journey”.

The four projects chosen are given as examples and may be changed when the material is developed (partly depending on feedback from stakeholders – see below) but their choice was seen as an opportunity to address the topics identified by the IIG subgroup and summarised in section 2 above. The projects chosen are:

- a) Flying by light aircraft and helicopter and spending a week with a risk assessment team on a North Sea oil rig (Oil Rig Delta Tango);
- b) Helping to identify and deal with risks at a construction site being developed by their company
- c) Involvement in the design and production of a ‘swamp buster’ hovercraft for crossing marshland in a developing country (this is in the form of a community project); and
- d) Involvement in the investigation of a major incident at a plant in Europe or North America, where ‘people’ issues and organisational factors have had an important part to play in the incident.

The development of each element of the journey and how it relates to the material to be taught will now be described. Some illustrations of the type of support material and associated assessments will also be outlined. A presentation outlining the proposed approach has also been developed and the slides from this are available as a CD accompanying this report

### **4.1 Introduction to the material**

In order to catch the attention of those using the package, it is proposed that it begins with a dynamic introduction. In line with the discussion in Section 2 of this report, this might contain four elements:

- a) A series of video clips showing major disasters. As well as being dramatic, these would be designed to illustrate the human element and the impact on the engineers involved (e.g. the impact on the mission control team as they realised that the Challenger Space Shuttle had exploded on take-off).
- b) An interview with someone who has been injured in an industrial accident. This, again, would be designed not just to explain the circumstances of the accident, but its impact on the lives of the victim, their colleagues and their family.
- c) Interviews with well-recognised engineers or business leaders explaining the importance of the issue to them, to their organisations and why aspiring professional engineers need to understand and address them.

- d) Scene- setting for the four projects (“the journey”) and an introduction both to the format of the proposed material and to the simulated characters who figure in it.

#### **4.2 Oil rig “Delta-Tango”**

The three young graduates first fly by chartered light aircraft from the south of England to Aberdeen and then, following training, fly by helicopter to the oil rig. On the oil rig, the team spend several days with a group carrying out an audit of activities on the rig. Exactly what is simulated will depend on further discussion with experts and on production and cost factors. Suggested simulated activities might include observing a drilling operation, involvement in an emergency exercise and/or a maintenance operation. Issues like the importance of good communication during shift handovers and the role of procedures and work instructions might be illustrated.

However, the main objective of this element of the ‘journey’ is to introduce a debate among the team, and thus with the student, about the risks involved, perception of risk, how far we need to go in reducing residual risks and the legal framework underpinning this. The issues tested could include the following:

- The difference between terms (which are often, confused) such as risk, hazard, danger etc.
- The relative risks of different activities.
- How and why ‘measured’ risks are often different from perception. The need to understand the views of stakeholders.
- How safe is safe enough?
- The legal framework in the UK
- The importance of some everyday risk control measures in a high-hazard, complex working environment.

To illustrate the approach which is being proposed, the first three bullets in the above list will now be considered further.

As the team prepare to embark on their project, they hold different views about the risks that they will face. For example, one of them may be concerned about the risks involved in flying in a light aircraft; one may be more concerned about spending time on the oil rig. The student using the simulation is invited to consider the issues being debated and, in effect, participate in the team discussion. To facilitate this, simple briefs would be made available summarising the points of view being put forward and giving some help to the student in formulating his or her own judgement. A simple exercise would test understanding. These latter two activities would constitute the ‘support layer’ in the three-layer structure for the material outlined above.

As examples of the way this might be done (for illustration purposes only), Figure 2 shows a table giving the approximate risks of death arising from both activities which might be familiar to the student and from various occupations. The student would be invited to ‘place’ the risks associated with some of the simulated activities (e.g. flying or living on an oil rig) into the table of risks and would be given feedback and assessed on performance. They would then be invited to move on to the next part of the package.

Figure 2

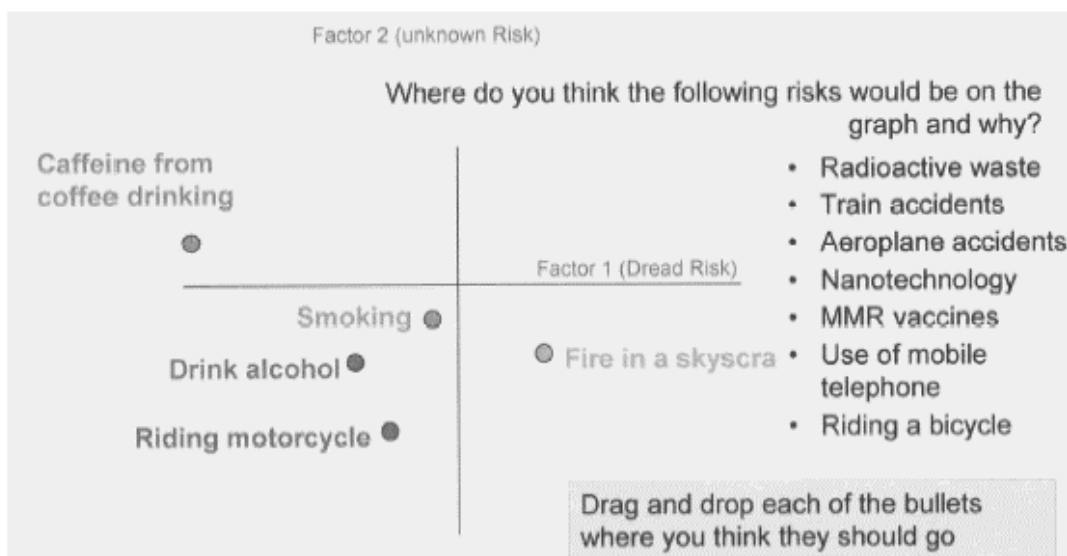
• Hang gliding once a week	1 in 2,300
• Rock climbing once a week	1 in 6,000
• Road accident	1 in 17,000
• Working in construction industry	1 in 17,000
• Working in manufacturing industry	1 in 77,000
• Railway accident (one return journey/week)	1 in 430,000
• Flying on commercial aircraft (1 return/wk)	1 in 1.25M
• Struck by lightning	1 in 18M

**Try placing these:**

- Risk of dying on a light aircraft from London to Aberdeen?
- Risk of dying on a helicopter flight from Aberdeen to North Sea oil rig?
- Risk of working for one week on a North Sea oil rig?

A similar approach might be used in relation to risk perception. In 1987, Slovic surveyed a range of risks and placed them on a simple grid<sup>4</sup>. This attempted to identify the factors, which led to public perception of risks being different from scientific assessments. It included factors such as dread, controllability, familiarity with the risk etc. A brief explaining some of the issues involved (perhaps including more recent theories) would be made available. Against this background, the student might be invited to consider issues relating to the public perception of both some everyday and some more controversial issues. An exercise to provoke thought and test understanding might involve ‘dragging’ a number of such issues into an appropriate part of a grid similar to that developed by Slovic. This is illustrated in Figure 3. Feedback would again be given to the student.

Figure 3 (Note: reprinted/adapted with permission from “Perception of Risk”, Slovic P, 1987, Science, 236, 280-285. Copyright 1987 AAAS.)



### 4.3 Construction site

The example in 4.2 may be more familiar in its context to mechanical or chemical engineers. This proposed example would be more relevant to civil and structural engineers. Furthermore, it deals with issues arising in an industry sector where there has recently been a major drive for improvement, given the historically high injury and fatality rate.

The simulation would be of a construction site recently inherited by the company for which the young graduates are working. They have been asked to join a team trying to make improvements to safety on a site with a hitherto poor safety record. The issues tested in this simulation might include the following:

- Conflicts between the need to intervene or otherwise act to improve safety and pressures to ‘turn a blind eye’. This introduces issues relating to codes of conduct for engineers and broader ethical principles. It allows responsibilities as individuals (duty of care etc) to be addressed.
- Recognition of hazards in the work place (e.g. use of PPE, tripping hazards, lifting and handling, electrical hazards etc). The scenario provides an excellent vehicle to explain and assist in this.
- Identification of hazards leads on to the concept of risk assessment. The scenario provides an opportunity for students, through the activities of the simulated team, to learn the principles and to gain practical experience of a simple risk assessment.
- Failure to identify hazards and control risks has implications for health and safety of individuals, but also significant cost implications. These are frequently much greater than normally recognised. Use of the HSE’s “Accident Cost Calculator”, for example, would enable the students, through the activities of the simulated team, to be able to assess the cost implications of accidents and ill-health.
- Although primarily concerned with health and safety risks, the simulation of a construction site would provide a vehicle for some aspects of environmental risk control to be addressed and the principles underpinning this.

### 4.4 Local community “swamp buster”

The third scenario involved the team being ‘loaned’ by their company to assist with an engineering project in a community in a developing country. The project could take many forms, but to provide a significant challenge, the team assists in the design and operation of a simple, small hovercraft to be used to transport essential supplies to villages otherwise isolated by swamp land. Another alternative might be a wind turbine to provide a local electricity supply. This project allows a significantly different series of issues to be addressed. These include:

- The trade-off between cost and benefit in terms of improved safety for a real project – i.e. how safe is safe enough?
- The management of risk in a project from inception to completion – i.e. cradle to grave risk control.
- Designing a device to be safe when it is to be operated by people who, in addition to normal human limitations may, in addition, have limited technical capability – i.e. taking account of the human factor.
- Examples might be given of engineering projects which have achieved excellence and others which have failed in terms of health and safety – i.e. learning from the experience of success and failure.

#### **4.5 Learning from a major accident**

The final project involves the team in the investigation of a serious incident at one of the company's overseas facilities. The explosion at the plant involves several failures involving electrical supplies and control and instrumentation, and would thus be seen to be particularly relevant to electrical engineers. However, the main learning arises from an appreciation of how a series of minor failures can lead to a major event. The failures not only relate to engineered systems, but particularly to failures in procedures, other organisational issues and to human response.

As with nearly all major disasters, the exercise illustrates the fact that causes of 'organisational accidents' are complex. Ideas such as Reason's "Swiss Cheese Model"<sup>5</sup> of successive failed defences in complex systems could be used to illustrate the issues involved.

This also provides the opportunity to emphasise the need to learn from 'near-misses' in order to strengthen the layers of defence and the role that individuals can have in strengthening the safety culture in an organisation by exercising leadership, promoting communication and exhibiting a questioning attitude.

The key objective of this final part of the 'journey' is to get across the message that getting engineering 'right' is essential, but that this is a necessary but not sufficient condition for success or the avoidance of failure. People and organisational factors are also vital and everybody has a part to play in this.

#### **4.6 Concluding section of the package**

It is envisaged that the concluding section will provide a summary of the key learning outcomes. Consideration is also being given to providing a simple checklist of dos and don'ts, which individual engineers might carry with them as they embark on the world of work.

## **5. COST ESTIMATES FOR E-LEARNING MATERIAL AND IT ISSUES**

It is only possible at this stage to give broad estimates of the potential costs which would be incurred in developing an e-learning package of the type being proposed, along with the supporting material and the need for continued support. Based on advice from Logica CMG, as a result of their experience in developing similar packages for government and industry, costs of £30-40K per hour of material might be anticipated. Production of e-learning material of high quality in a “gaming” context could, however, be significantly higher. Estimates also depend critically on the “tightness” of the project definition and the need to avoid significant re-work. The type of material being proposed is not standard and furthermore, by its very nature, a project involving a wide range of stakeholders, each with their own expectations, would need to be effectively project managed in order to minimise cost escalation.

Greater clarity on cost etc will be available if the recommendation (see below) of constructing a “sample” or demonstration package is pursued. Cost estimates from Logica CMG for this specific proposal are given in Section 7.

No detailed survey of IT requirements and capabilities of potential end-users has been possible within this phase of the project, but universities in the UK generally have mature systems which are likely to be able to support the type of package envisaged. Logica CMG have advised that because maintenance and updating will be a significant requirement (see Section7), the material would be better developed as web-based rather than distributed on CDs. This would help to ensure that quality is maintained and up-dating and sharing of new material managed effectively. Further work will be required, in discussion with the HEA Subject Centre and others, to investigate in greater depth any potential IT support and related logistical issues.

## 6. STAKEHOLDER FEEDBACK ON OUTLINE PROPOSAL

### 6.1 Identified stakeholders

A very important element in the work programme agreed for this project was to test emerging ideas against the views of a wide range of relevant stakeholders and obtain their feedback. Those consulted fell broadly into four groups:

- **The IIG, individual Engineering Institutions and the Engineering Council (UK).**

In addition to a general interest in ensuring that graduate engineers have some understanding of health, safety and risk matters, the Engineering Institutions and Engineering Council (UK) have an interest in ensuring that requirements for the accreditation of engineers include a level of competence in these issues and that there is material for training available, against which such requirements might be judged.

- **Individual universities (staff and students) and the Engineering Subject Centre of the Higher Education Academy.**

Currently, the extent and quality of the teaching of health, safety and risk issues in UK universities is patchy. This probably reflects the subject's interdisciplinary nature and the relatively small amount of research being carried out in the UK compared with other important subjects. There is also, currently, a recognised shortage of resources for teaching in this subject area and it is difficult for staff, without special interest or knowledge, to get to grips with the subject. However, several universities are keen to develop new material to meet their requirements. The University of Liverpool Engineering Department<sup>6</sup>, for example, is already pursuing this as part of a project to broaden the teaching of undergraduate engineers. Young engineers themselves should have an interest in ensuring that they not only meet the requirements of their university courses, but are equipped to achieve accreditation as chartered engineers in due course.

- **The HSE (and the Health and Safety Laboratory).**

As the funding organisation of this phase of the project, the HSE sees the teaching of health, safety and risk issues to undergraduate engineers as an important step in developing a higher profile for them. It eventually hopes to see this result in improved health and safety performance. This is recognised in the HSE's strategy, for example, in its document 'Revitalising Health and Safety'<sup>2</sup>. The Health and Safety Laboratory has considerable relevant expertise and has, for example, been supporting the developments at The University of Liverpool, mentioned above<sup>6</sup>.

- **Industry**

Companies of all sizes, which employ engineering graduates, have an interest in ensuring that their recruits have some knowledge of health, safety and risk issues. This is not only of intrinsic value in providing more rounded recruits, but the material being developed, whilst not specifically designed for this purpose, may provide a basis for training within companies. Input to the teaching material from companies is important in order to ensure that it reflects priorities and issues in the workplace. In providing support for the project, companies are also able to show their commitment to the subject, and to the HSE and the objectives of the Engineering Institutions and Engineering Council.

## 6.2 Organisations approached

In order to gain the maximum feedback possible within the constraints of the project, meetings were held with the following organisations:

Inter-institutional Group  
Engineering Council (UK)  
University of Bristol, Civil Engineering Department (including students)  
University of Liverpool, Engineering Department (including students)  
City University, Engineering Department (including post graduate students)  
Higher Education Academy, Engineering Subject Centre, Loughborough  
University  
Engineering Professors' Council  
BP  
British Airways  
Corus  
Health and Safety Laboratory

In addition, progress with the project is being reported to the Presidents of the major institutions and to their Accreditation Boards. An invitation is being extended to provide further details of the work and feedback has been welcomed.

Notes of meetings with ten organisations consulted are contained in Appendix 2 to the report.

## 6.3 Feedback received

There was a unanimous view among those consulted that the project was welcome; that it filled a gap in currently available resources, and that the interactive approach and three-layered structure was likely to be successful.

This support was very welcome but was also supplemented by a substantial number of excellent, constructive comments and suggestions. The notes of the meetings attempt to capture as many of these as possible, but comments which are of individual potential interest (in the context particularly of further phases of the project) include the following:

- Do not overestimate the knowledge and capabilities of the student user.
- Keep the material modular and give guidance on how it can be used in practice (for example, in relation to the existing curriculum). Consideration might be given to ways in which the material could best be split-up for teaching purposes. A view was expressed that the course might best be taught at the start of year 3 or the very end of year 2.
- Have material available for testing at an early stage. Pilot this with potential end users.
- Be prepared to brief/coach teaching staff and provide further resources for them. Specific material may need to be provided or referenced to help them, particularly for use in tutorials.
- Clarify learning outcomes and ensure that these are outlined at the start of the material, with a summary at the end. Specify the skills that are to be developed. A simple “one-liner” mission statement might be developed.
- Make Accreditation Boards in the Engineering Institutions aware of the developments, and achieve the maximum alignment possible with the “UK Spec” for chartered engineer accreditation.
- Consider using simpler and familiar scenarios. These may be preferable to using the less familiar examples.

- Ensure that each engineering discipline recognises those specific parts of the package which relate to their interests (e.g. a construction site will be of particular relevance to civil engineers).
- It is vital that the material is kept up-to-date and a mechanism found to achieve this.
- Understand and resolve issues of software compatibility before any substantial investment is made.
- Make sure the ‘gaming’ material is of high quality; otherwise students will not find it attractive in comparison with video games.
- Look for a combination of first principles, concepts and practical skills as outcomes: for example, the ability to draw up a ‘risk register’ or carry out a simple risk assessment should be considered. The idea of students having to make decisions based upon limited information and then justifying them and discussing them in tutorials or other group sessions is important to retain.
- Consider the possibility of using mini-projects, case studies or exercises for further development, as part of the third layer. Account might be taken of projects currently undertaken in some university departments including lab work and field trips.
- It will be necessary to highlight the inter-disciplinary nature of the subject, its relative ‘immaturity’ and to consider definitions particularly carefully.
- Decisions need to be made about the extent and nature of the assessment – particularly final assessments. Production of progress printouts or ‘diaries of progress’ for the user should be considered.
- Consideration will need to be given to use by students with disabilities.
- The use of ‘gaming’ techniques to provide examples (e.g. of spotting hazards) followed by a random selection of test material for each student is seen to be a particularly useful approach.
- As material is developed, it will be vital to understand academic needs and to make university staff aware of the project. A mechanism should be found for this.
- Consideration should be given to developing a prototype package incorporating some of the techniques and learning outcomes. This could be used to promote interest and awareness and to explore funding routes.
- Make the material more ‘controversial’ by relating it to environmental concerns. Using newspaper headlines etc might be considered.
- In the longer term, applications in schools, industry etc may arise. This should be taken into account when exploring funding routes.
- In presenting the approach, the advantages of an e-learning package over other learning material should be stressed.
- Many companies are stressing the need for excellence in occupational health and safety but the engineer’s role in minimising the frequency and impact of major events is sometimes given less emphasis. Inclusion of this was strongly supported by one company. They also believed that the role of PSA and safety cases might be subjects for the third layer. A contrary view was also expressed. Since most engineers will not be involved in major events, but will have to deal with day-to-day health and safety issues as part of their management responsibilities, the focus should remain on these.
- The relevance and application of the material to SMEs should be dealt with as the majority of students join smaller companies. Major companies will have their own training material in health and safety but SMEs may not.

## **7. ISSUES FOR FURTHER CONSIDERATION**

From the feedback received and as a result of discussions among the project team, eight broad areas have been identified which require further consideration. These are:

### **7.1 Use by Engineering Institutions for accreditation purposes**

All of the Engineering Institutions require chartered engineers to have some knowledge of the issues addressed by this project. The extent to which they are specified in requirements, however, is variable. From discussions so far, it appears that the provision of material to assist in engineering 'formation' would be welcome. The main issue is, therefore, to ensure that those responsible for accreditation in the institutions are aware of the work being undertaken and have the opportunity to comment and provide input to the next phase. To this end, a letter is being sent on behalf of the IIG to the Presidents of the major Engineering Institutions and to the Chairman of the Accreditation Boards, making them aware of the work, welcoming their input and offering further information. The role of the Engineering Council (UK) is also very important given that the proposed material will be generic. They have indicated that, in addition to membership of the IIG, they wish to be kept closely involved with the project. Support for the material as a means of potentially meeting accreditation requirements will be an important factor in uptake at universities.

### **7.2 Publicity and feedback for the academic community**

The project has been strongly welcomed by the three university departments which have received presentations. One of the universities (Liverpool) is currently developing its own material on the subject in conjunction with the Health and Safety Laboratory. They would like to be able to influence and then use the material being produced in this project and arrangements will be made to facilitate this. Other universities (e.g. City) have indicated that they may wish to be part of any trial of the material.

A presentation was given to the Engineering Professors' Council (EPC) in January 2006. In the earlier phases of the project, the EPC gave support to the work, with the caveat that it should not add to the existing curriculum and should be used to support existing course work. They continue to support further work and representation on the Steering Group for any further phase of work should be offered, in recognition of their important role in support of the project.

The engagement and potential role of the Higher Education Academy Engineering Subject Centre has proved to be extremely important. Their feedback on the proposals was very valuable and they have accepted an offer to be more closely involved in further work. They could help to achieve a successful outcome in two ways. They have expert knowledge of academic capabilities and requirements, furthermore they have an existing network database and capability to publicise developments through newsletters, electronic communications and regular events. This would be an excellent means by which the work being undertaken can be brought to the attention of the wider academic community, feedback obtained, interest maintained and the material produced used effectively.

### **7.3 Continued support to users**

Several stakeholders have raised the important issue of how any material might be maintained, updated and further developed after any initial package has been produced. As feedback is received, material in the second 'layer' (briefings and assessments material) will need to evolve and the development of 'partnership' material in the third 'layer' may require some coordination, if only to publicise what is developed by individual university departments. The HEA, Subject Centre at Loughborough could, again in principle, play a vital role in this. There is significant interest in e-learning material and the possibility of further funding for the subject centre in order to support material after development should be pursued.

### **7.4 Production of briefing and assessment material**

Some resources have been developed in outline to support the current work. However, if the project moves forward to a further phase, further advice and input from health and safety risk experts and potential academic users will be required. It is anticipated that the IIG subgroup, suitably augmented by representation from other stakeholders identified in this report, may be able to identify the needs and then develop briefing and assessment material to support the video material. To ensure consistent quality and suitability, this input will need to be carefully coordinated.

### **7.5 IT issues**

Further advice will need to be taken on the capability of university departments to use and support the software requirements associated with the project. It is anticipated that materials will be web-based rather than distributed as CDs in order to ensure that quality and updating can be maintained. At present, no issues have been identified by Logica CMG which cast significant doubt on the ability of university departments to use material in the form envisaged, although it cannot be guaranteed at present that specific problems relating to use will not emerge.

### **7.6 Costs**

Logica CMG will be able to provide a clearer cost breakdown for the total project upon completion of any "Sample Phase". Given the connection between the levels of interaction and the degrees of free stimulation it is difficult accurately to cost at this stage. Whilst the industry averages for computer based training range from £10,000 - £40,000 and upwards, this type of gaming simulation is less standard and more prone to cost increase. It is therefore vital tightly to manage the parameters of the project and the potential for rework. As an indication, costs for a "sample" are likely to be in the region of £40,000 - £50,000.

Further costs would be involved in providing coordination and management of the overall project and, although it is hoped that supporting materials for the second 'layer' would be produced on a largely voluntary basis, further costs could be associated with this. It is hoped that some supporting video clips and other materials required for the introduction and concluding sections will be made available free of charge by companies and others in return for acknowledgement of their contribution. Some material may also be available from library video material. However, such material would need to be reformatted and edited and the costs of this may be significant. Finally, it was noted above that costs would be associated with overall project management, coordination, promotion and presentation of the material to university departments.

## **7.7 Timescales**

Based on the current study, it is difficult to be precise about timescales for production of a complete package along the lines suggested above. Timescales are unlikely to be determined by the production of simulations. Given that much of the input for the second ‘layer’ would, it is anticipated, be provided on a voluntary basis (through, for example, the IIG subgroup), this is likely to be the rate-determining factor. Allowing for the considerable degree of coordination required to draw together the various elements of the package, a working estimate of 1 year from agreement on funding to final product seems reasonable at this stage.

## **7.8 Funding**

There are two ‘streams’ of work which may require separate funding. The first is the production of the package, including coordination and implementation. Four potential sources of funding for this have been identified, but at this stage these have not been pursued. This would be a major activity for further work.

It is recommended, however, that gaining support would require a short package of demonstration material to be developed in order to explain the concept to potential funding bodies, give them further confidence that the project is viable and provide a firmer basis for cost estimates and timescales. The sources of funding which might be explored, given this demonstration materials might include:

- Government Departments (e.g. Department of Education and Skills)
- The HSE
- Charitable Foundations
- Industry

In the case of industry, it is thought feasible that major companies may be prepared to donate relatively small sums of money or provide input material if, for example, credit was given by displaying the corporate logo or otherwise acknowledging their contribution as part of their corporate social responsibility programmes.

The second ‘stream’ of work which has become clear during the current phase of work, relates to the interface with users. Here the input and expertise of the Higher Education Academy Engineering Subject Centre at Loughborough University is believed to be potentially very important to the longer-term success of the project. Opportunities for exploring augmentation of the existing activities of the centre to become engaged with the production, promotion and continued support of the package should be explored with the HEA at an early stage in any further work.

## **7.9 Other issues**

Three other issues have been noted. Firstly, further consideration needs to be given to the need for supporting material for the package. This could range from promotional material through to the possibility of a short accompanying workbook and support for academic staff in teaching the subject. Secondly, the assumption has been made that materials required for the project will be freely available. Considerations of accessibility of support material and, particularly, issues of copyright will need to be explored. Finally, a number of stakeholders have suggested that a clear set of objectives and learning outcomes should be written to accompany the material.

## 8. CONCLUSIONS AND RECOMMENDATIONS

The current phase of work has achieved four things:

- A clear overall concept and structure has been developed for the package based on the 'three layers'. It has been demonstrated that the proposed IIG teaching material can be integrated within the proposed approach. A presentation package has been developed and used to explain what is proposed to stakeholders. To the extent possible, short of producing actual material, the concept has been proven and it is judged that the project can proceed with confidence to a further demonstration phase (see below).
- Based on the concept and approach proposed, discussions have been held with a range of stakeholders, including potential end-users, bodies with an interest in its use for accreditation purposes and industrial companies. Overall strong support has been expressed for the project and the general approach proposed.
- A 'feel' has been obtained for costs and timescales and for a range of logistical issues. In particular, a potential way of achieving continued support in promotion and liaison with end users has been identified as an important issue to pursue further.
- Clarity has been achieved about the steps that need to be taken in order to provide further confidence and to generate funding. The main conclusion is the need for a short demonstration package to be produced, drawing on elements of the presentation developed for discussion with stakeholders.

As a result of the interaction with stakeholders and discussions within the project team, the following further steps are recommended:

- Given uncertainties about cost, timescales and some logistical issues and the need for good quality, realistic material to explain and support the proposed approach, the production of a demonstration or "sample" module is proposed. This is the main recommendation for the current phase of work. The short demonstration might contain examples of introductory material (video clips), simulated e-learning material from one part of the 'journey' (e.g. the construction site), and along with associated briefing and self- assessment exercises. The demonstration might cover some broad concepts (e.g. relative risks and risk perception), together with some practical material (e.g. identification of hazards, carrying out a risk assessment and calculating the cost of accidents and ill-health). It is estimated that a suitable demonstration module could be produced in three to four months and would cost about £40,000 - £50,000
- Based on this demonstration, it is recommended that discussions take place with potential funding organisations, some of which are identified above.
- A major conclusion of the study was that a mechanism should be found to support the promotional use of the final package with university users. Agreement and the exploration of potential support for the Higher Education Academy Subject Centre to carry out this role should be pursued. Follow up of potential IT support issues will also be required.
- If the project is to be a success, it is essential that all the key stakeholders identified in this report feel a sense of ownership for the aims and principles of the project. This has been achieved successfully so far through the Inter-institutional Group. It is recommended that the subgroup of the IIG which has been providing input and consensus on the work should be asked to continue to sponsor the work and be augmented with representatives of other identified stakeholders (e.g. the HEA, HSL, individual university departments, EPC, industry) so that it can act as a full project steering committee which represents the needs of the wide range of stakeholders involved.

- Support for the project from the Engineering Institutions and the Engineering Council (UK) is vital to its long-term success. In addition to the letters being sent to the Institution Presidents and the Chairmen of their Accreditation Boards, it is recommended that this is followed up by offers of presentations and/or further discussion, especially with those responsible for accreditation policy.

## 9. REFERENCES

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

1. *Outline of Proposed Undergraduate Engineers' Teaching Material on Managing Risk*. Produced by the IEE on behalf of the Inter-Institutional Group, 2003
2. *Revitalising Health and Safety – Strategy Statement*, HSE and DETR, HMSO, OSCSE0390, 2000
3. *Education of Undergraduate Engineers in Risk Concepts – Scoping Study*, Lee J F, 1999, *HSE Books C2.5 10/99*
4. *Perception of Risk*, Slovic P, 1987, *Science*, 236, 280-285
5. *Managing the Risks of Organisational Accidents*, Reason J, 1987, Ashgate Publishing Ltd, Aldershot, UK, ISBN 184014:142
6. *Risk Education in Engineering – Development of Year One Materials*, Schleyer G K, Duan R F, Stacey N and Williamson J, 2006, HSL Internal Report

## APPENDICES

**APPENDIX 1          SUMMARY PAPER**

Summary of topics covered by IIG undergraduate teaching material on risk

# Summary of topics covered by IIG undergraduate teaching material on risk

## 1. Why the issue is important

- Eye catching examples (one from each discipline e.g. Piper Alpha)
- Inputs from eminent engineers (i.e. why the issues are important to them)

## 2. Risks in perspective

- Different concepts (e.g. risk and hazard)
- The “systems” approach to risk issues (looking here at health and safety, but the learning is wider)
- Costs and benefits and how we can assess them in simple cases
- Complexity in real decision making ( e.g. concern about health effects of mobile phones – perhaps one or two examples across disciplines)
- Factors which influence public perception of risk
- Given all this, what are our responsibilities as engineers to look at the wider views of all stakeholders?

## 3. Moral, Legal and Ethical Issues

- Codes of conduct/ethical issues
- Responsibilities as employees and employers – duty of care
- Broader responsibilities (e.g. environment/sustainability/corporate responsibility etc.)
- Legal framework (structure of UK law, AFAIRP, Precautionary Principle, R2P2 etc.)

## 4. Benefits and Costs of EH&S

- Benefits in personal, financial and business terms of good EH&S and why organisations and individuals should make it a priority
- Costs associated with “everyday accidents” and other losses/near hits (Bird Triangle, free lessons from near-hits etc.)
- Costs and other impacts from actual and perceived disasters viewed from the point of view of individuals, companies and society (with some examples).

## **5. Engineering Issues**

- Need to consider risks “cradle to grave” (all stages from design to decommissioning and how these interact)
- Good “conventional” engineering is vital, but management systems and an understanding of the impact of the human factor are also vital.
- The importance of understanding occupational health issues in design and in the workplace
- Management systems and their importance ( e.g. HSG 65)
- Key elements in managing risk (the hierarchy of risk control )
- Importance of properly managing change (engineering and organisational) and the danger of “late” changes (examples)
- Examples of excellence in design and operation minimising risks
- Examples of failure and why this occurred (possible simulations)
- Awareness of how “organisational” accidents can occur and why they are complex (e.g. Reason’s Swiss-cheese model) and examples - e.g. Columbia, Piper Alpha (one example from each discipline?)

## **6. Safety Culture**

- Key elements of a good safety culture (leadership, communication, questioning attitude, learning etc.)
- What we can do as individuals (impact of our own behaviours and some examples of how we can influence the elements above)

## **7. What are the key H&S issues in the work place and how can we help to control them?**

- Identification of the main H&S issues of which we need to be aware in the workplace
- Techniques for spotting hazards and carrying out risk assessments (possible video game on hazard spotting and then the use of HSE 5 steps etc to show how risks can be controlled)
- The importance of “challenge” and some hints and approaches to dealing with people (up and down)

## **8. The Bottom Line**

- Summary of key points and reminder of our role as individual engineers
- Final video clips and interviews with peers about their experience and approach

Dick Taylor 25<sup>th</sup> May 2005 (revised 12<sup>th</sup> July)

**APPENDIX 2**  
**SUMMARY NOTES OF MEETINGS WITH STAKEHOLDERS**  
**TO DISCUSS THE PROJECT**  
**(SEE SECTION 6.2, MAIN REPORT)**

Inter-Institutional Group	(21 <sup>st</sup> September)
Engineering Council (UK)	(30 <sup>th</sup> November)
University of Bristol	(16 <sup>th</sup> November)
University of Liverpool	(14 <sup>th</sup> December)
City University	(2 <sup>nd</sup> December)
Higher Education Academy	(29 <sup>th</sup> November)
Engineering Professor's Council	(19 <sup>th</sup> January)
BP	(15 <sup>th</sup> December)
Corus	(19 <sup>th</sup> December)
BA	(3 <sup>rd</sup> February)

## **INTER-INSTITUTIONAL GROUP ON HEALTH AND SAFETY SHE TEACHING MATERIALS WORKING PARTY.**

Institution of Civil Engineers  
Institution of Chemical Engineers  
Institution of Electrical Engineers  
Institute of Mechanical Engineers  
Hazards Forum  
HSE

### **Notes of the meeting:**

**Wednesday 21<sup>st</sup> September 05 at the Institution of Electrical Engineers, London  
(Amended Extract from Minutes)**

#### **1. Project Update.**

The meeting was convened to discuss the progress of the project. The members of the IIG and the teaching materials sub group were invited to attend.

The HSE decided to build on the work of the sub group and engaged Logica CMG and Dick Taylor to develop it to the feasibility stage. They have also been working with the University of Liverpool, School of Mechanical Engineering to investigate undergraduate teaching and they aim to connect the two streams of research into something concrete in the near future.

Any output must be of value to the universities and of interest to the students. The intention is that the material will not be “just course work”, but lead to the understanding that health and safety is a natural part of risk management.

The meeting received a presentation from Dr Taylor and Mr Vincent Smyth (Logica CMG) on their proposal. Their concept is e-learning using an interactive computer “game”, where the student undertakes an imaginary first job, which involves a series of challenges at various locations around a virtual world (e.g. on an oil rig or developing a new product). Each challenge would be designed to bring out some of the key risk issues identified in the IIG summary document, with all issues covered by the end of the game. Progression through the game is achieved by passing the challenge, although there will be no right and wrong answers. It will be possible to jump in and out of the game, enabling lecturers to tailor it to their needs.

The discussion of the proposal produced a number of points:

1. Do not overestimate the knowledge of the undergraduates.
2. In general, men are more interested in computer games than are women. Care will need to be taken to make it appeal equally to both sexes.
3. Be very careful about identifying countries. You may cause an international diplomatic incident by suggesting that a particular country is less safe!
4. It would be good to put something for Civil Engineers in there. What about the composites factory being at least partly a construction site
5. A very strong point was about length and use in practice. How will universities pull out bits which are relevant to specific courses/teaching requirements etc (words like bite size, portfolio, menu etc were used in the discussion).
6. Thought very important to try out on some students, young engineers and staff as soon as we can
7. Staff will need some training and /or other material to get a proper understanding and be one step ahead of the students
8. It would be useful to think about some of the actual situations and scenarios which would be presented e.g. what will actually be shown of the oil rig and what will happen

9. Learning outcomes should be defined
10. The narrator might be a young engineer recently chartered with whom our students can identify
11. Industry may find it useful and their support should be pursued for funding and input
12. There were several detailed points e.g. make sure the human element and difficult working conditions are covered
13. Try to get the support of the Institution Accreditation Board Chairmen at an early stage
14. Without overdoing the technical detail, try to make sure that each engineering discipline feels it recognises their technology
15. Some concerns about how it will be kept up-to-date, whether university systems will be able to support it, compatibility of software, how it will be distributed etc
16. A concern that given the professional, very expensive material which students are used to in video games - will it look a bit cheap and cheerful in comparison over time?
17. Consider operating system compatibility (some universities may use old software).

The IIG endorsed the approach. The plan would be to supply the software free to universities, so financial support will need to be found. It was suggested that companies might be willing to support the project in return for some publicity. Funding may also be available from the government's skills agencies. The HSE plans to take the proposal to key stakeholders around the country to get their views and suggestions before proceeding to the next phase. It was estimated that it would take up to 18 months to develop the software.

The IIG agreed to help to drive the project forward and will assist with gaining acceptance by the course accreditation bodies.

## Outline notes on meeting with the Engineering Council (UK) on the IIG Undergraduate Risk Teaching Project - 30 November 2005

**Present:** Paul Bailey, Ian Freeston, Brian Fullam, Dick Taylor, Vincent Smyth, Paul Davies (Richard Shearman was unable to attend and gave his apologies)

**Discussion:** The current status of the project was summarised. It was noted that at an earlier stage the EC(UK), through Andrew Ramsay and Richard Shearman, had given strong support for the work and it had been noted as a potential input to accreditation requirements. The following further points were raised in discussion:

- The EC (UK) felt that the proposed approach was promising and offered broad support (on the understanding that it was not seen as a project of the EC). They felt that a good start had been made in designing a “product” which should prove valuable. The “three layer format was strongly supported. It would be important to get the views of students, however.
- It was regarded as important to get the continued support of the Engineering Professors’ Council (EPC). It was thought likely that universities would strongly favour a modular structure.
- Experience suggested that the main current use of supporting material on H and S in universities, would be in such areas as risk assessments in laboratories and as material to support projects.
- Clarity about learning outcomes would be important. For example, the ability to carry out a simple risk assessment based on the material presented, would be particularly valuable.
- It would be useful to stress what an e-learning package is able to deliver as compared to a book or instructional CD. Improved motivation, awareness and a more holistic view of the subject might be important, together with the sense of involvement and the ability to present information in a way which has more impact and “immediacy”.
- It was considered important that the material should be capable of being updated. For example, as fashions and styles change, students may be less attracted to the material presented if it is not kept reasonably up-to-date. The quality as compared with games material could also be important.
- The terms used are likely to be important. It was suggested that the term “undergraduate training” on the title page be replaced by “H and S Professional Engineering Formation” (or similar)
- Whilst support from the EAB (see above) is important, informing and gaining the support of the individual institution accreditation boards is also vital. The aim should be to get the “kite-mark” for the material from each of these boards. It may be helpful to align the material against the “UK Spec” in order to achieve this.
- In the shorter term, it was recommended that at least part of the material is available in demonstration form. This should include both generic and practical elements if possible and examples of the three layers. This could be used to try to get further support from the Department of Education and Skills and from industry. Even a short, high quality sample would be useful for this purpose.
- In the longer term, it was suggested that the material might form a basis for teaching of the subject in schools, company training packages and use in other applications. This possibility may make it even more attractive to Government and to bodies with a broader remit to develop training and curricula.

## Key points arising from discussion at Bristol University on “Teaching of risk concepts to undergraduate engineers”- 16th Nov. 2005

A presentation on progress with the project, including examples of e-learning material developed by Logica CMG, was given to Prof. David Blockley and two third year undergraduate civil engineers. The following feedback was given for further consideration by those developing the material:

- Define what skills the student should have at the end of the modules
- List the intended key areas of learning up front in the presentation (4 or 5 key issues to be covered)
- In addition to the general knowledge gained, give one or two practical outcomes e.g. ability to draw up a risk register or simple method statement at the end.
- End the modules with some exercises or mini projects on which the student can test her/his skills
- Give some more insight into what sort of issues would be covered whilst on the oil rig
- The oil rig is not something to which many undergraduate engineers would be able to relate. It may be better to concentrate on more familiar examples e.g. travelling by plane, train, car etc. or more familiar technologies with a broader engineering context.
- Would it be possible to relate some of the material to natural disasters in order to engage student concern and interest?
- Emphasise that the subject is an “immature” discipline” and that concepts, definitions etc. may be defined and interpreted differently
- Take particular care with definitions – even something like risk are defined in a variety of ways internationally (e.g. between the UN and the HSE)
- Can the material be tailored to support specific projects in departments? - at least it would be useful to make the connection that this might be done.

The overall conclusion was that the material was welcome and useful. The concept of the three layers was thought to be good and the students felt that the interactive hands-on approach had a good potential for learning if it was well produced.

RHT

## **Outline Notes of Meeting on Undergraduate Risk Teaching Project at the Mechanical Engineering Centre at Liverpool University on Wednesday 14<sup>th</sup> December 2005**

Present:

Dr Graham Schleyer, Dr Tim Bullock, Professor Peter Goodhew, 4 students (Shelley, Alison, Nick and Andros)

Dr Brian Fullam, Dave Bell

A presentation was given of the current status and plans relating to the project. Feedback was invited and possible future interaction between the work of the University and the risk-teaching project was discussed. The following points were raised in discussion:

- It was felt that the degree of graphics fidelity needed to be high given the predominance of visually capable X-Box devices. The point was made that higher fidelity tended to cost considerably more for relatively small gains and that for this project it was felt that the technical content was a higher priority than high fidelity graphics.
- The question was raised whether sub-titles could be made available. This is something that we had not given any thought to, but is a possibility. However, the additional cost versus greater usability would need to be considered.
- The teaching was seen as effective as was the testing of learning. A further question developed as to whether it would be possible to grade the tests so that at the end of the course, the student could be given their score and a grading. Liverpool run a 'blackboard' intranet where students log in and it might be possible to access this learning through that means. It would be desirable therefore that proof of having completed the course and credit gained could be registered on their system (or a simple printout given at the time of completion).
- Overall, given the intended content of the course, it was felt that some form of splitting would be necessary since students might not have the full period of 2 to 3 hours available in one session. It was stated that the course would be modular, and broken down into several sub-sections but given that there would be no student management system built in, the student would need to finish on whole sections or sub-sections, ready to start the next section in sequence.
- It was felt that there could be some additional benefit gained for small parts of the learning materials to be disseminated to tutors in PowerPoint format for their use in tutorials, or as reference material on the subject.
- During the analysis of risk, it was felt that very few students used motorcycles and so were possibly not in an informed position to assess the risk. It was suggested that cycling would be a better option and that the risk of being mugged would be topical.
- Finally, the question was asked where the course would be best positioned. After some debate, the consensus reached was that it would be best placed at the start of Year 3, or after the exams in the 2<sup>nd</sup> year.

## Notes of meeting with staff and students at City University on undergraduate risk teaching – 2<sup>nd</sup> Dec 2005

**Present :** Prof Philip Thomas, Prof David Stupples and two PhD students with Dick Taylor

**Discussion:** The background and current status of the project was summarised. The following points were made by the students and staff in discussion:

- Overall broad support was given to the aims, content and general approach being proposed.
- The student view was that if well presented, the “gaming” approach would work well with most students.
- Each element of the material and the final attainment should be assessed. This ensures that students take it seriously.
- It will be important to challenge the strong student but not deter those who find it more difficult. Assessment scores in the range 40% to 80% should thus be the target
- The idea of using random or varying material was felt to be well worth pursuing – for instance in a hazard spotting context.
- Consideration might be given to using examples of “disasters” which are “closer to home” e.g. rail disasters
- The eminent speaker mentioned as a possible contributor for the introduction need not be an engineer.
- The concept of a safety case and its importance should be covered.
- In the oil rig simulation, instead of just showing normal production, some of the high hazard work associated with “wildcat” work might be used.
- In the “Slovic type” risk perception material, issues like the AIDS virus might be included.
- Some kind of “sliding scale” for types of hazard instead of just using numbers might be introduced to provide a clearer picture to the issue.
- It would be important to ensure that women were given prominence in the material – to match the drive to make it clear that engineering is a career for women as well as men. Topics like risks in the NHS might add to the relevance and interest to women who may take up engineering.
- Experience of producing professional material of this kind had shown that using a producer was valuable
- Clarity about learning outcomes was important but these should be kept to a small number of practical issues
- The material might be made more interesting by adding controversy/”conflict” through including newspaper headlines to give impact or by having a character who is a journalist or “environmentalist” around the team. The use of cartoons or a cartoon character (“cartoon clippy”), might also increase interest and fun.

In welcoming the proposed material, Philip Thomas felt that City would be pleased to consider being a “guinea pig” for the project and consideration would be given as to how this might best be achieved

## **Outline Notes of Meeting on Undergraduate Risk Teaching Project at the Higher Education Academy Engineering Subject Centre - 29<sup>th</sup> Nov. 2005**

### **Present:**

Brian Fullam, Dick Taylor, David Bell  
John Dickens, Carol Arlett, Simon Steiner

Following an explanation of the role of the Centre and its links with the HEA and other related bodies, a presentation was given of the current status and plans relating to the project. Feedback was invited and possible future interaction between the work of the Subject Centre and the risk-teaching project was discussed. The following points were raised in discussion:

- Overall, it was felt that the approach being suggested could be successful and the e-learning format and proposed layers provided a useful basis for tying the various elements of the teaching together. Production of material on the subject was felt to be timely and should fill a real current gap.
- It would be helpful to clarify the learning outcomes expected and how assessment would be obtained – particularly a final assessment..
- The possibility of including model “case studies” might be investigated. This would give academic staff greater clarity on how to use the material - in supporting project work for example.
- In developing the package of material, it would be important to recognise that academics would have a variable knowledge and interest in the subject. This would need to be reflected in the “third layer” of supporting material
- The importance of the subject matter would be seen to be even greater if alignment with the “UK Spec” could be demonstrated.
- Some form of “diary” or “progress print-out” may be valuable for the student. This would provide a link to the learning and the outcomes intended, and allow progress to be logged.
- Consideration should be given to the issue of access to students with disabilities. Advice was available on this.
- The idea of using the material to teach the student about some aspect of health and safety (e.g. spotting hazards on a site) and then testing understanding by generating random test material for individual students was felt to be very valuable.
- Consideration needed to be given to keeping the material up-to-date – for example to reflect evolving accreditation requirements.
- The use of “gaming” had much to offer and should appeal to students, but it would be important to ensure that the material used was of a standard that would be acceptable compared with video games. Keeping it up-to-date in terms of fashion etc may also be a consideration. The video clips shown looked good.
- It is important to understand how the material will actually be used. For example, if modules are required to support teaching, it would be helpful if the material was designed to facilitate this and examples given of how it might be done.
- Advice might also be needed on how the material could best be “stitched” into the curriculum.

- The HEFC is funding e-learning programmes and through JISC, it was possible that funding may be provided to subject centres for specific projects. This might be further investigated as a potential means of enabling a close practical supporting link to be developed between the next phase of the project and the Subject Centre.
- The Loughborough Centre has considerable experience in raising the awareness of academic staff (through the 86 engineering departments with which it interacts) about projects and new resources of this type. It maintains a database of resource material on its web site and organises specific events to discuss and get feedback on issues and developments. It also issues a newsletter.
- An important consideration is the use of pilot and/or user groups. The centre again has experience of organising these. Trial material may be worth considering before going ahead with the whole package.
- Other points and links were also noted including expertise in the OU, the possibility of interacting with similar work in Australia, the TEEG group looking at ethics and work at Birmingham University on disaster management. Contacts would be made available.
- Some practical issues may need to be considered regarding use. For example would all universities have the facilities to run the package? how might it best be made available (web, CD etc)? and issues such as the availability of sound (e.g. in a teaching lab) could be important.

## **Conclusions**

This was a most valuable meeting, apart from the many valuable points made above, the following key outcomes were identified:

1. The next phase of the project would require expertise of the type that the subject centre could offer. They have kindly offered to interact further and be part of any steering group, but any means of securing even stronger involvement should be investigated.
2. The ability of the Subject Centre to facilitate interaction with potential users and to give publicity/encourage use is most valuable. The potential for maintenance and support of the material after it has been developed was also seen as potentially very valuable. As with 1 above, possible funding through the JISC/HEFC route could be investigated.
3. The idea of producing a pilot or prototype package, perhaps based around one module or part of one module, should be considered as a next phase of the project. This could be used as a basis for further interaction with potential users and sources of funding as well as providing a further trial of the proposed approach

## Outline Notes of Meeting on Undergraduate Risk Teaching Project at the Meeting of Engineering Professors at the Royal Academy of Engineering – 19 Jan 2006

### **Present**

Brian Fullam, Vincent Smyth

A presentation was given on the project although this was somewhat truncated given time constraints. In the discussion the following points were made.

- There was near complete support for the approach we were proposing.
- Support for our proposals could not be translated into financial support
- Access to the material was seen as an issue. They were reassured that the software would be web based and free to use. John Dickens from the Engineering Subject Centre was present and supported my suggestion that the Centre could host the material
- Updating and refreshing the material was an issue
- The three level structure, with the ability for institutions to add material, was strongly supported
- No comments were made on the scenarios we had identified
- Manchester University expressed interest in participating in development

Overall, I thought the level of interest could have been higher. The impression I gained was that the subject was peripheral to their main interests. Support was offered as long as it did not require substantial input from them. However, on the upside, it was clear that if the material were provided in the form we suggest, it would be used.

## **Outline Notes of a Meeting on the Undergraduate Risk Teaching Project at BP - 15<sup>th</sup> Dec. 2005**

### **Present:**

**John Baxter, Mike Considine (BP)**

**Dick Taylor, Vincent Smyth**

A short presentation was given of the current status and plans relating to the project. Feedback was invited and possible future interaction between BP and the risk-teaching project was discussed in outline. John Baxter and Mike Considine were active within their professional institutions and also gave their views from this perspective. The following points were raised in discussion:

- The objective of the project was strongly supported. It was also seen to tie in well with activities in the I.Chem.E. designed to raise understanding of these issues.
- It was suggested that some further material involving issues such as PSA might be considered. It was agreed that this may be suitable for “level 3” in the proposed structure.
- At a later stage in the project, BP would be interested in considering whether the material could be of use for internal training.
- The emphasis in several places on the engineer’s role in minimising the risk of disasters was seen to be very valuable. Occupational health and safety issues were now receiving very strong emphasis in many safety-conscious companies, but addressing the risks of larger scale events was fertile ground for the training of young engineers.
- BP would discuss the project internally and would consider what role they may be able to play in the next or subsequent phases. DT and VS emphasised that input of material (e.g. video clips) and/or involvement and advice would be very welcome. Some of the overheads would be made available to JB in order to facilitate further discussion in BP.
- In summary, BP would welcome further potential involvement. The need for the work was recognised and supported and the general approach, involving e learning, together with the three layers of material, appeared to be a helpful approach which was also supported.

RHT Dec. 2005

## Outline Notes of Meeting on the Undergraduate Risk Teaching project with Corus at the Ashorne Training Centre – 19<sup>th</sup> December 2005

Present:

Eric Clubley, Paul Rathkey, Gareth Pugh, Chris Rowles, Sardar Khan (all of Corus)  
Dick Taylor, Vincent Smyth

The Corus representatives at the meeting covered a wide range of company backgrounds – health and safety, corporate training, graduate recruitment and a recently recruited graduate engineer. Dick Taylor thanked Corus for fielding a team with wide knowledge and interests relevant to the project.

A presentation was given of the current status and plans relating to the project. Feedback was invited and the following points were raised in discussion:

- The general objective and approach was welcomed. The material was seen to fill a gap in undergraduate courses. The proposed format was likely to be useful and the use of e learning was seen to be a potentially good vehicle to provide memorable learning.
- Relating the learning to “doing” and, in particular, to decision making was seen to be a potentially valuable approach.
- The objective of teaching the first principles of the subject should be kept in mind in further developing material. It should provide a framework and a language against which later learning and experience could evolve. It should aim to raise awareness rather than achieve knowledge transfer.
- Some areas such as risk perception could become “woolly”. It is necessary to root the material in principles and practical objectives. A hierarchy of objectives from giving students a framework, vocabulary, some tools and some methods may be appropriate.
- Consideration should be given to developing a one line “mission statement” for the project. Learning outcomes should be made clear.
- Since day-to-day health and safety issues are the ones which most engineers will need to address in their work, these should be given prominence over more ambitious objectives to address the causes of disasters
- If the disaster module is retained and developed, it should be based on a simulated event – not one that the student could investigate and find out about the causes, without thinking through the issues.
- It should be made clear that the material is *not* aimed at H and S advisors but attempts to arm students for things that they may come across in their jobs as engineers.
- The question might be asked whether the proposed content has been partly determined by the proposed e-learning format. Content should be agreed first and only then should the best vehicle to get it across be considered.
- The relevance of the material to graduates joining SMEs might be considered. Reference might be made to needs in this context.
- Ideally, following each element of the teaching material, students should have the opportunity to debate issues in groups or tutorials. If teaching staff are to facilitate these discussions, the demands on their time and knowledge needs to be recognised.

- The material should be subject to assessment. In that way it is more likely to be taken seriously and not just seen as an unimportant adjunct to more interesting core engineering coursework
- The link to chartered engineer requirements is likely to be an important factor in whether it is taken up and used by universities and students.
- Corus wish to be kept informed about developments. If a short sample of the material were produced, they would welcome further discussions about content, use and potential involvement in further phases of the work.

## Outline notes of a meeting with British Airways on the Undergraduate Risk Teaching Project – 3<sup>rd</sup> February 2006

**Present:** David Anderson (Head of Ground Safety, BA) and Dick Taylor

A presentation was given of the work undertaken as part of the current phase of the project and the background and likely future developments were summarised. The following points were raised in discussion:

- BA are currently not recruiting graduates to any significant extent as a result of their ongoing organisational changes. As a major organisation with a strong engineering capability they were, however, interested in the work presented.
- The global nature of the organisation means that they have used a variety of learning techniques for training staff at locations around the world. This includes e-learning. They thus have a good appreciation of the advantages and disadvantages of the approach and would, in principle, be prepared to share this experience in due course with the project team. The approach was seen to be useful in the proposed context and in providing a form of learning which should appeal to young people, although this would depend upon high quality material being developed.
- It was felt to be important that young engineers should have an appreciation of H and S matters at a basic level as part of their undergraduate training. BA would expect some understanding of the fundamentals and of the importance of the issue at recruitment interviews etc.
- The importance of “people issues” was emphasised and the proposed approach was seen to be valuable in emphasising the need not only for good engineering, but also for stressing these “soft” skill issues.
- Whilst an understanding of the fundamentals of occupational H and S was seen to be of particular importance, the need for an appreciation of how complex, organisational accidents can occur was also supported. Particularly important is the need to emphasise the role of the individual’s responsibilities, ethical considerations and the need to participate in improving E, H and S. Giving young engineers the confidence, some knowledge and some tools to do this (e.g. an ability to spot hazards, carry out simple risk assessments and interact confidently with staff and management was strongly supported).
- In summary, BA supported the project, felt that it would meet a clear need and felt that the approach and topics covered were appropriate. The need to give students an appreciation of relative risk, risk perception and the need to consider the broader systems issues was seen to be important
- BA would welcome a further presentation when a “sample” module is available (this was thought to be a valuable next step) and would at this stage consider whether they are able and willing to give further support to the work.

RHT Feb 2006



**MAIL ORDER**

HSE priced and free  
publications are  
available from:

HSE Books  
PO Box 1999  
Sudbury  
Suffolk CO10 2WA  
Tel: 01787 881165  
Fax: 01787 313995  
Website: [www.hsebooks.co.uk](http://www.hsebooks.co.uk)

**RETAIL**

HSE priced publications  
are available from booksellers

**HEALTH AND SAFETY INFORMATION**

HSE Infoline  
Tel: 0845 345 0055  
Fax: 0845 408 9566  
Textphone: 0845 408 9577  
e-mail: [hse.infoline@natbrit.com](mailto:hse.infoline@natbrit.com)  
or write to:  
HSE Information Services  
Caerphilly Business Park  
Caerphilly CF83 3GG

HSE website: [www.hse.gov.uk](http://www.hse.gov.uk)

RR 452