

SC/10/064B

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THE EDUCATION BASE: SAFETY RELATED ISSUES

[written for the IStructE Academics' Seminar in September, on the teaching of structural engineering, and as a Topic Paper]

"Education of engineers should deliver professionals who understand their professional responsibilities for the safety of the public, including the need to act on safety critical defects, and who can apply the principles of risk management."

Lord Cullen, Hatfield Rail Enquiry

Background

This note is written as a contribution to the IStructE's debate on the teaching of structural engineering at undergraduate level (on which it is holding a seminar in September 2010), for the general information of ICE and HSE, and for wider debate.

The delivery of structural engineering (in its broadest sense) at University is relevant to SCOSS in so far as undergraduates need to be introduced to the concept of (safety) risk and its management. Structural engineers are, above all else, risk managers.

The paper identifies 'risk' issues relevant to structural engineering undergraduates (Table 1) and then compares these to those required under more generalised occupational health and safety risk management (already incorporated into engineering degrees). It is suggested that the synergy can be utilised to provide an integrated approach.

Risk management

SCOSS supports the JBM in its requirement for all University courses to include a 'safety' thread throughout a course's duration. Structural Engineering is a safety-critical profession, and formally recognised as such^{1,2}

However, this thread is best expressed in 'risk management' terms³ whereby structural safety, whilst usually the most important, is just one element, alongside for example, finance, weather, serviceability, procurement et al, that have to be considered by designers, constructors and those who use and maintain our facilities. This 'safety' thread should allow civil and structural engineering students to appreciate, at an appropriate level:

¹ by the Health and Safety Executive.

² In addition, the Revitalising Health and Safety Statement 2001 (DETR) gave specific backing to the incorporation of risk management in undergraduate courses.

³ which is how JBM approaches 'occupational health and safety'.

Table 1: structural engineering risk issues

- Margin: the role of partial factors,
- Uncertainty and inaccuracy.
- Hazard and Risk
- Learning from past mistakes
- Behaviour of structures
- The role of checking and review
- Limitations of Codes and their background assumptions (in a generic sense)
- Duty: moral, duty of care, statute, contract.
- Modelling validation and verification (Prof Iain MacLeod has done much on this subject)
- Robustness
- Buildability

A number of these overlap with occupational safety matters, which JBM also presents in terms of risk management. Reference 1 suggests degree courses should include:

Key Issue	Sub-element
Responsibility:	Personal Corporate
Obligation/Ethics:	Moral Professional Common law duty of care Contractual Statutory
Nature of risk:	Uncertainty Incompleteness of data Constraints e.g. time, resource, finance Hard and soft sources of risk Likelihood and severity
Balance:	Avoiding unnecessary time spent on trivial risk Concept of 'reasonable practicability' Absolute duty Low probability/High consequence events
Management	Safety culture, human factors Hierarchy of risk management: (E liminate, R educe, I nform and C ontrol (ERIC)
Learning from mistakes	Study of past failures Root causes

Thus 'structural safety' fits well within a generic approach.

It is not expected that undergraduates become proficient in safety risk management. That is not realistic as they lack the vital ingredients of training and experience⁴. However it is important that they appreciate the concepts (Queens Belfast used to include a 'learning from failure' module, led by Alan

⁴ Competency being the mix of education, training and experience.

Jennings: this was recognised as an exemplar in its field and was designed to introduce undergraduates to many of the fundamental issues surrounding failure [2]. Some other centres adopt this approach- Warwick includes a forensic engineering module).

Risk Management at Liverpool University

Liverpool University has some significant experience of incorporating risk management issues into the curriculum, across a general engineering background. It has done this in conjunction with HSE and others as a formal partnership. The Health and Safety Laboratory (HSL) has played a substantive role throughout this partnership, and more widely in this field.

Stemming from this work, HSE has recently commissioned research into the provision of risk management in engineering undergraduate courses [3]. This concluded that:

On graduation students should be able to demonstrate *knowledge and understanding* of:

1. Concepts of hazard, safety and risk as part of everyday life;
2. An engineer's professional responsibilities for safety and managing risk;
3. Principles of hazard identification and risk assessment relevant to the discipline;
4. Methods of hazard identification and risk assessment relevant to the discipline;
5. Techniques for reducing and controlling risk;
6. Personal safety and potential exposure to hazards and risk in the workplace; and
7. Underlying causes of accidents and failures.

On graduation, students should be able to demonstrate *ability in applying knowledge* of the topics to:

1. Design simple engineering systems for safety accounting for uncertainties;
2. Perform a risk assessment using appropriate methods, avoiding some of the common pitfalls, and implement, where necessary, effective risk reduction measures;
3. Learn from documented failures and accidents the underlying hazard, safety and risk issues and relate this knowledge to their future professional responsibilities; and
4. Identify and control safety hazards to themselves and others in the course of work activities.

These items also give a good match with the items previously quoted.

This Report is an excellent summary of why risk management is important and how it may be delivered. It tackles the known challenges of incorporating 'risk management' into undergraduate courses. It is supported by other research [4].

Teaching

Many of these items do not need specific teaching time or modules as they can be 'drip-fed' into the course over the full 4 year term. However, this means that the topic does need a cross-curricular implementation policy and hence whole-department buy-in. Teaching aspects were reviewed some years ago by HSE [5] and are covered also in reference 3.

The key challenges to improved teaching of safety risk management are;

- Demonstrating that it can be done without further undue loading of the syllabus
- Obtaining whole-department buy-in
- Providing teaching materials for use by academia

Conclusions

SCOSS recommends that:

- i) **IStructE, in its current consideration of how structural engineering should be taught in undergraduate courses, considers also the integration of 'structural' safety risk management across the curriculum.** This is the key recommendation.
- ii) in support of this action a more detailed review should take place as recommended also by Rita Donaghy⁵ [6] (for the benefit of all those supporting JBM) in order to:
 - Map the suggested contents and subjects against JBM requirements
 - Identify good practice delivery mechanisms
 - Identify and overcome barriers to progress.
 - Integrate risk management education with other aspects of structural engineering delivery at undergraduate level,

and that:

- iii) this should be done taking account of work by others (specifically under the auspices of IIG⁶ and HSL) so as to avoid duplication.

References

1	Whole life competence Carpenter J. Civil Engineering November 2006
2	Viewpoint: The need to upgrade experiential learning Jennings A, International Journal of Engineering Education Vol 14, N 2,p83-88 1998.
3	Integrating risk concepts into undergraduate courses HSE Research Report RR702 2009.
4	Risk Education in Engineering Development of Year one materials HSL/2006/61 HSL 2006
5	Identification and Management of Risk in Undergraduate Construction Courses Carpenter J, Williams P, Charlton-Smith N. HSE Research reports 392/2001 and 275/2004
6	One death is too many Rita Donaghy Report to the Department for Work and Pensions July 2009.

⁵ This was given support in the Government's response, but the onus for delivery was transferred to ConstructionSkills.

⁶ Inter-Institutional Group (IIG) on Health and Safety . This includes ICE, IStructE, IMechE, IChemE, Hazards Forum, HSE.