REMIX: Mathematics in the University Education of Engineers

Last year, the Ove Arup Foundation commissioned myself and my colleague, Professor Richard Noss, to undertake a small research project to survey the current roles of mathematics in undergraduate engineering education in the UK, with a particular focus on civil engineering, and to identify some visions of future directions for the teaching of mathematics. The research took place from May to December 2002, using a methodology of interviews and visits with universities, professional institutions and civil engineering companies, supported by a literature review and a questionnaire survey of university civil engineering departments. The final report on the research has just been published (see below for download addresses).

Mathematics plays a central part in the formation of civil engineers in the UK, both in the form of an entry requirement to undergraduate courses, and as a core underpinning element of those courses. The role of mathematics in civil engineering has been a high-profile issue for some years, and the issue came to the fore last year when the professional institutions for Civil and Structural Engineering decided to stimulate debate by temporarily removing the requirement for A-level mathematics as an entry qualification to civil engineering degrees.

Looking across engineering education and engineering practice, there appears to be a major contradiction in regarding mathematics as a problem or as an opportunity. The pressing need to recruit and retain students on engineering courses means that it has been natural for academics to focus on the “mathematics problem” at the interface between school and university. Yet the role that mathematics plays in professional practice has changed radically in the last 30 years. Today, “computational mathematics” is perceived as a tremendous opportunity, pushing forward the boundaries of civil engineering design. Within this, mathematics as explicit work by individual engineers has evolved into mathematics as a distributed activity across design teams and the computers which support them. How is this change reflected in current engineering mathematics teaching in the UK? As we see it, mathematics is both a problem and opportunity for universities: the question is how to educate students mathematically to master the mathematics-based technologies of practice?

We found agreement from every quarter that undergraduate engineering students continue to need to know and to learn mathematics, and the report addresses a set of questions facing engineering mathematics education:

- What kinds of mathematical knowledge do engineers need?
- When and how should mathematics be taught?
- How can the “essential” level of mathematical knowledge for engineering practice be characterised? On what does this knowledge rely?
- How does computer technology change this situation?

All these questions are becoming particularly pertinent because the system of mathematical education in engineering formation is in a ripe situation for change: regulatory frameworks for the development of professional engineers, entry routes to the profession, and school mathematics provision will all be experiencing major changes in the next few months and years.
This report has gathered together a range of opinions, ideas and proposals, and is offered as a stimulus for debate. The report is freely available to download from several web sites, and any comments will be most welcome:
http://www.theoveryarupfoundation.org
http://www.ioe.ac.uk/rnoss/REMIT

Teaching and Learning Research Programme announces new project

The Teaching and Learning Research Programme (TLRP) is a major initiative of the ESRC, supporting research projects and related activities at many ages and stages in education, training and lifelong learning. The Programme is concerned with patterns of success and difference, inclusion and exclusion through the lifecourse. Recently the TLRP launched its new portfolio of 18 post-compulsory projects which includes one relating to mathematics. The project team consists of Celia Hoyles, Richard Noss, Phillip Kent and David Guile at the Institute of Education, University of London, and the project will run from October 2003 - March 2007. Phillip Kent writes:

Techno-Mathematical Literacies in the Workplace

The widespread presence of IT systems has led to major changes in many industrial and commercial workplaces. Managers now need to make decisions on the basis of analysis and evidence from the IT systems, which require understanding something of the analytical models on which they are based. Compared with past requirements for general mathematical literacy in the workplace (being able to calculate and estimate), what is now required is something considerably more complex: “techno-mathematical literacies” (TmL) - fusions of mathematical, IT and workplace-specific competencies that demand an ability to deal with models and to take decisions based on the interpretation of abstract information. This kind of “complex literacy” is not in itself a new phenomenon - such understandings have always been required of relatively few, highly-trained employees. But IT brings unprecedented complexity to workplace systems, and it implicates increasingly more people to have to engage with IT systems and to interpret their outputs both qualitatively and quantitatively.

Developing TmL is a major skills challenge facing UK industry and commerce. This project will design work-based training that aims to develop TmL skills, especially for time-served employees, based on a pilot group of companies in a range of industrial and commercial sectors. The project will begin by close observational study of the companies involved to identify the TmL used by managers. It will then design and test a system of multimedia-based training modules to develop TmL. In doing so, the project will address an often neglected area in lifelong learning, namely the continuing development of non-graduate employees. The modules will integrate multimedia presentation of episodes from the workplaces with “open” IT models and simulations (that can be inspected and changed) of the workplace systems.

The modules and their assessment procedures will be widely disseminated to industry through professional institutions and post-16 teaching and training bodies, as exemplars of effective work-based training of TmL. By working with such organisations, the project will address issues regarding new forms of qualification and accreditation to support employees’ career development, and to strengthen existing systems of work-based training.

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