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Briefing

Geotechnical engineering education and the lost 60 000; who mislaid them? A personal view

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1. INTRODUCTION

As I pen these thoughts on geotechnical engineering education I am reading Professor John Atkinson's recent thought-provoking article[1] on the nature of our business and the way in which we educate professional civil and structural engineers and our specialist geotechnical engineers. In it he quite rightly alludes to the non-specialist geotechnical engineers, the 'lost 60 000', and how they need to be engaged in the discussions on the nature of our work as specialists.

For twelve years I taught geotechnical engineering to undergraduate civil engineers and engineering geologists. I am now a 'recovering academic'. My view is therefore one of erstwhile educator, current practitioner and potential employer. My time in higher education was mostly an enjoyable and rewarding experience, thanks to the students and good colleagues. I also had the pleasure of working alongside John in the mid-1990s when we were both involved in the GeotechniCAL Higher Education Funding Council (HEFC) funded teaching project. Thinking back, I am sadly aware that a very significant percentage of our geotechnical academic colleagues around at the time have, like me, either returned to industry or retired. That so many experienced geotechnical engineers are no longer contributing to the education of civil engineers should be a worry to industry.

Currently in higher education, what was once good in the engineering arena is being rapidly destroyed. Vice-chancellors see fieldwork either as 'jollies' or as a health and safety risk to be avoided; specialist engineering laboratories are seen as underused teaching spaces, and engineering courses as recruitment liabilities. The influence of the Engineering Council (now the Engineering and Technology Board) via SARTOR 3[2] has been akin to the ancient practice of bleeding the sick patients to 'make them better'. If we add into this pot the effects of the research assessment exercises in creating 'paper-writing machines', who occasionally lecture unwillingly with little enthusiasm and who have no practical experience, then geotechnics in common with much of civil engineering education provision has a real problem for the future. Industry does see academia as extremely isolated and destructively introspective despite the many attempts that are made by both parties to change this perception.

2. WHAT WENT WRONG AND WHY?

John and I would agree over many fundamental points, and particularly the ridiculous drive to cram the latest *cause célèbre* into the overflowing pot that is the undergraduate civil engineering degree. But where I think we might disagree is where the 60 000 engineers became lost—and why.

Despite the provision of soil mechanics and geotechnics teaching to all undergraduate civil engineers for more than 40 years, the understanding of simple concepts is still woefully lacking. As the lectures and laboratories attended by geotechnical specialists at undergraduate level were the same as those attended by the overwhelming majority, the way in which the subject is taught has to be questioned.

Why did so little stick? Was it the rush to demonstrate the pet research topic or the latest constitutive model that left the majority behind? Was it the need to introduce material for the good examination question that left no time to go into the field to see slip surfaces in cohesive soils? Field trips, particularly local and UK-based, have great merit. In my experience as both lecturer and student the lessons learnt in the field stick surprisingly better than those in a tutorial— particularly when those tutorials are given by research assistants disinterested in teaching and who have little interest beyond earning enough extra income to live while they write up their PhD. Unfortunately that is the experience of many graduates, as the pressures of departmental administration, research targets and staff shortages mean that rarely are the most experienced geotechnical staff available for tutorials to answer questions and inspire interest beyond the mundane solution to the dry tutorial question.

Apocryphal accounts abound of civil engineering graduates suggesting $\phi = 90°$ for some soil because the natural angle of repose was vertical when they saw the slope first, or of undrained shear strength parameters not being used because land drains were present on the site. Were these people still struggling with the ideas of time dependence and soil permeability when the lecturer lurched into 3D presentational concepts and talked of failure surfaces in p' and q space? I wonder.

I would venture to suggest that much geotechnical work is

actually done by the lost 60 000, and a significant amount will have been wrong. Most geotechnical specialists have felt like the technical fire brigade at sometime or other. But our factors of safety and our working methods combine to reduce the numbers of apparent failures. We are also helped by structural engineers who habitually overestimate the actual loads on our structures, which is perhaps fortunate for us.

Clients and engineers alike appallingly undervalue site investigations. The influence of the Site Investigation Steering Group reports[3] since 1993 has been sadly imperceptible in the last nine years. Could it be that this is because site investigation is so often taught as an afterthought in undergraduate courses? John, I am sure, will have a wry smile when he reads these words. I know we would both agree that site investigation is no further forward now than it was 20 years ago—maybe even 40 years ago. As a profession we can only conclude that, if the basic work is not valued, then neither will be the specialist practitioner.

Can it be so revolutionary to suggest that undergraduate engineering education should be aimed at producing the future practitioner, equipped with an appropriate amount of basic theory and current practice, and not recreating the research-based lecturer in their own image? Education regularly uses simplistic ideas to convey a concept, and only later—when appropriate—moves away from the simple to discuss the complex. Children are shown in school that light is reflected and refracted, but only much later will they learn of the conceptual model that Newton developed, and perhaps even unwittingly dip into the area of quantum electrodynamics. It seems to me that what we try very often to do in geotechnics teaching is to introduce the complex model first, to explain the simple, when for the vast majority the knowledge that the simple exists is all that is required. I also realise that I shall be on the receiving end of some very strongly worded rebuttals of the approach I am suggesting, but I would urge caution to those who might feel so aggrieved. Is the level of knowledge in the profession about the potential behaviour of soils and rocks, developed by current curricula, satisfactory? Does the level of professional indemnity claims associated with issues of ground performance justify self-congratulation?

3. RECRUITING UNDERGRADUATES

There are also problems with developing those who *do* need to climb to the broad geotechnical uplands. Industry has to support specialist MSc provision, and the industry and the Institution must wake up to the realities of student recruitment in our universities. The most recent slight upturn in the UK of last year's recruitment figures, because of a sharp decline in IT-oriented careers, can only console the very foolish. The next 'craze' will just as readily wipe out these gains in future years. The whole picture has to cover the issue of undergraduate retention and graduate salaries, and the conversion of the student into the professional practitioner. The slight increase in numbers through the doors of UK universities should not be seen as signs of the problem solved.

All is by no means lost, and in geotechnics we have work that can excite and inspire the young. To this day the Rissa[4] landslide film can still generate the 'gee whiz' factor, as any visit to the Norwegian Geotechnical Institute website will confirm. The restoration of the tower at Pisa is a truly remarkable technical achievement, and has been the subject of television coverage that has brought the ingenuity of what we can do to a wider audience. Professor Burland has most successfully demonstrated to the wider public the expertise that lies behind what can be achieved by geotechnics. What is more, much of our work in the field of contaminated land meets with the aspirations of the young to safeguard the environment. But I have to ask: are we generally strong enough protagonists of our work?

4. CONCLUSION

So in conclusion what do I think we should do? Geotechnics is almost unique in civil engineering education in having the Meeting of Teachers in Geotechnical Subjects conference, which meets to discuss the teaching of its subject and its relevance to the industry. Industry as a whole needs to take far more interest in this valuable window into academia.

Undergraduate education needs to have the clear view that it equips the generalist civil engineer with basic understanding of the performance of soils, perhaps in artificially simplistic terms, and should not try to prepare the specialist or the next generation of researcher. This must be the role of the taught MSc, and here too industry has a very important part to play.

Particularly at undergraduate level we should be inspiring about fieldwork, placing emphasis on the importance of thorough site investigation and concentrating on a few clear messages uncluttered by explanatory concept models. Examination questions should be set not to impress fellow academics but to test the understanding of basic and simple concepts. Perhaps then we shall not have lost souls saying 'I never understood my geotechnical lectures; I took the advanced structural analysis option in my final year!'

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