Preaching to the Converted

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Gray, dear friend, is all theory. But green the golden tree of life.
Johann Wolfgang Von Goethe (1749–1832), German poet, dramatist. Mephistopheles, in Faust I, second Study scene (1808).

For many years the profession has been attempting to alter its public image with the aim of attracting more able entrants. This paper argues that with the attrition rates approaching 50% in many university courses there is more to be gained by addressing this problem. A number of causes are suggested. The first of these is that our current image is that held by those we do attract. Why this is a problem is that this image is fundamentally at odds with the course they are entering. This is exacerbated because the disparity is greatest in the first year but has lessened by the fourth. The students expect practicality and find abstraction. They expect physical construction and find mental reduction. Above all they are unprepared for the depth of mathematical analysis which will be demanded of them.

Different again is the role of the professional. It is closer to the entrants conception in some ways than the degree course as it is more applied and in general involves less calculation. It differs, however, in that the application is rarely hands-on and the complexity is an order of magnitude greater than that encountered in university that, itself, is an order of magnitude greater than the naive conception of the entrant.

The paper presents summary findings of several surveys conducted with students and graduates that support the above contentions. Included in these statistics are a longitudinal survey of students and recent graduates’ perceptions of the role of the engineer and the nature of engineering, sandwich students’ reactions to placements, and students’ perceptions of laboratory work and innovative educational approaches.

A number of possible approaches to mitigation of these problems are suggested. It is rather chastening, however, to note that most of these will have been proposed before, but few have been implemented. It is suggested that this is because of the reactionary nature of academe. I may not even be the first to propose that there is much to be gained by preaching to the converted. Can we move the entrants’ preconceptions of engineering courses halfway towards what they will encounter - and then move our engineering courses halfway towards their perceptions? Perhaps then we could significantly reduce attrition, particularly amongst those who drop out in first semester. This could go a long way to reducing our numbers problem - and, dearer to my heart, avoid disillusioning many aspirant engineers, many of whom still profess a desire to enter the profession.

INTRODUCTION

For very many years the engineering institutions and others have mounted elaborate campaigns with the aim of changing public perceptions of professional engineering. They maintain that our public image is equated with mechanics and electricians, whilst our true role is depicted as science. The profession is certainly not seen as “glamorous” e.g. [1] and this
may be one of the reasons for schoolchildren’s reluctance to choose engineering as a career path. It is interesting that while studies show that engineers hold “a set of positive attitudes about their discipline”,[2], even they believe their public image to be unglamorous. Meanwhile the engineering industries report a steadily increasing skills deficit. The campaigners hope that by altering the public image we can attract more able youngsters into engineering degree programmes.

Tonkinson and Gazey [1] showed that, while schoolchildren did not think that the engineer had a glamorous role they did generally perceive it to be creative and interesting. The majority even believed it to be exciting! These perceptions generally concurred with industrialist’s assessment of their own roles but conflicted with the views they expected the schoolchildren would hold.

Despite the many initiatives, universities report declining recruitment and high attrition rates. Nor is this a problem confined to the U.K. At a recent international conference delegates from many countries, including the USA and Japan reported similar problems. The efforts have mainly been targeted at the first of these problems - recruitment. This paper addresses the second - attrition. It presents in summary form the results of two surveys, one of undergraduate students, the other of drop-outs. It also discusses a model of the engineer’s formation proposed by the author.

**THE SURVEYS**

(i) The undergraduate survey, conducted by questionnaire and interview, sought the perceptions of our current BEng students on their course and their perceptions of the role of the professional engineer. Prior to entry, the students did expect to have to learn theory and showed anxiety about the maths involved. But they were anticipating a practical approach with background theory. Instead they reported finding what they viewed as highly abstract theory with occasional, largely unconnected labs. A previous survey, [3], has shown that engineers identify with role of experimenters and practitioners. Comments abounded on our failure to provide contextual practical examples of the theoretical models we analysed.

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Table 1: Summarised results of undergraduate perceptions of engineering and their course

Interestingly, by the final year student’s conceptions of their future roles had polarised into two main groups. The larger (66%) had, if our graduate surveys are to be believed, a realistic view of the role, which they were eagerly anticipating. The remainder were dreading what
they saw as a continuation of slogging through mathematical calculations, largely working alone in an office environment. This is a side issue but surely one also deserving of our attention. Most Graduates (63%) find their work challenging and exciting but people management and personal and interpersonal skills are perceived as at least as important as technical knowledge and ability. The remainder, those dissatisfied complain of being undervalued and not being given scope to use their skills. They remain committed to engineering but are seeking more challenging occupations. Few are highly critical of their degree programmes but they maintain that it was too abstract and theory orientated. Even after graduation they find it hard to see the relevance of much of what they learned. They recommend more applications, more project work and more emphasis on technical managerial skills.

(iii) The “drop-out” survey

A questionnaire, deliberately brief in the hope of a better return was issued to ex-first year students. 14 responses were received from the 52 forms sent out. 2 respondents were interviewed. Of the 14, 9 had withdrawn while the remainder had failed assessments. In contrast to the “survivors” only 3 students commented on the lack of practical but 9 students cited difficulty with maths or theory as reason for withdrawal while 5 had found the work load too onerous. “I felt out of my depth in terms of the amount and type of work required compared with the actual time I had”, was a typical comment. 5 said they had simply lost interest in the course. Disturbingly 9 students said organisational issues had contributed to their decision. Respondents complained of lack of information, misinformation, lack of feedback, altered deadlines and unpublicised timetable changes.1 “I found the course very disorganised and disjointed, no organisation between lecturers, that sort of thing.” Only 2 mentioned financial problems.

I was interested in the syndrome which Elton [4] describes as the disenchanted elite. That is that our entrants have at school, been the star performers in a small class and been given special treatment. At university they find themselves given no special assistance in a large class and they are expected quickly to become independent learners. It was obvious from some comments that entrants did not understand or did not know how to approach sourcing information. “I was being asked to do a report on work I had not covered in class. This is non-sensical in my opinion” was what one ex-student said at interview. These problems leads to disenchantment and withdrawal. Whether it is evidence of this or not all but two of the respondents described themselves as having been near or at the top of their class at school. Several specifically commented on their unpreparedness for the university environment. One went so far as to suggest that we should introduce a summer school to acclimatise them to the university culture. Students were divided almost equally between those who had found the course close to their expectations and those who had not. It will be noted that this is in accord with the findings in the undergraduate survey. Problems with coping with the University approach are typified in the comment of one undergraduate. “I’m used to a class type learning where I am told what to do. Here I was sitting in front of lecturers and I did not know what was expected”.

1[ Note that a registery period was introduced this session specifically to address this problem.]
Fig 1 shows that our students in general do not feel that their schools prepare them well for their course

Fig 1 How well school prepared for University

DISCUSSION

The great majority of entrants are eagerly anticipating a practical hands-on future but are dreading the hard-work and maths they are anticipating. What they find is an assessment driven process and a theory dominated content. Loud and clear their main complaints are lack of practical content and what Herzberg would call hygiene factors, organisation etc. We interpret the shift from mathemaphobia to subject specific problems not as an indication that they have no difficulty with maths but that in the heavily mathematical engineering treatment they are additionally having difficulty with the concepts.

Lest it be thought that our students are unrepresentative compare their responses with a wider survey [5]. The survey of 353 undergraduates on conventional engineering courses and 220 recent graduates had similar findings. 74% of the undergraduates thought they had too little engineering practice and 61% thought that engineering applications was inadequate. Comparative figures for graduates at % and % were similar. Although not quite so stark 36% said they had had too much engineering theory and the same percentage too much mathematics. Corresponding graduate figures were not quoted but in both groups only a few percent said they had had too little of the topics. It seems therefore that even after up to 4 years in a professional post engineers see no need to revise their perceptions of an overly mathematical and theoretical bias in their course with insufficient attention being paid to application and practice.

Two conclusions stand out in the drop-out returns. Firstly, even more so than the “survivors”, they deplored the lack of practical work and found the subjects difficult and were frustrated by perceived bad organisation. But secondly, contrary to the opinions expressed by many academic staff, they still strongly wish to become engineers. These findings chime with those of an earlier survey, [6] of entrants during their induction. Self-descriptive statements and interviews revealed strong desire to become engineers and the motivation to succeed. We reluctantly must draw the conclusion that it is not against engineering that they have turned
their heads, but against undergraduate engineering degree courses. We must find ways to capitalise on the positive attitudes of entrants.

I recently proposed a model of the engineers formation [7] in which I suggested that while still at school an individual forms a naive view of the role which is attractive to them. On entry to university the gross disparity between what they expected and what they encounter can have a dramatic effect. Add to this the loss of elite status, the need to cope without a great deal of support and an assessment dominated culture and it is not surprising that many experience dissonance. Wankowski [8] states that “emotional disenchantment arising from an initial academic and social disorientation on entering university is one of the most important factors in student failure. My contention is that the many campaigns mounted to try to attract more able youngster into engineering, while perhaps not emphasising the practical aspects do little to prepare the entrant for an engineering course. As Eraut [9] has it “this entails years of continuous encounters with propositional knowledge in its codified, public forms”. If we truly believe this highly abstract and mathematical approach to be a necessary preparation for an engineering career then surely it is incumbent on us to prepare entrants for the experience. Much work has been published on problem based learning (PBL) and how it can enhance the educational experience. There is, however, a tendency to leave this to later years in engineering courses. The argument given by staff is that the students need the theoretical underpinnings before they can meaningfully tackle technical problems. I do not believe this to be true. Problem based approaches to science have even proved effective in primary school. I myself, have successfully introduced the approach at induction [10] and in first year laboratories (paper in preparation)

So let us try to pull together what my evidence shows. Firstly engineering does have an unglamorous but not unexciting image among schoolchildren. Attracted or repelled by it their conception is generally of a predominantly hands-on practical occupation. Those we attract are generally strongly attracted to engineering as a career - 60% of those to a hands-on practical and 40% to a “heads-on” practical. Both are disappointed by the abstract treatment - but we lose far fewer of the minority group.

Our courses appear unexciting, abstract and, frankly, tediously arduous. They turn students off engineering courses not off engineering. Whether or not they stay the course, they still remain committed to the profession. Nor do our courses match the needs of industry Fig 2 Graduates and employers report insufficient ability to apply the theory and to engage in project work.

So - in preaching to those who have selected engineering as a career we may better prepare them for the “heads-on” approach they will encounter. We don’t just show them the labs and workshops at open days or concentrate on the build aspect of project completed by students. We must admit to even sell the challenge of the intellectual demands of engineering. Let’s face it maths is necessary - and hard work. Can we not sell the satisfaction of solving a difficult problem. But - solving problems can be, in Stevenson’s [11] words, is “drudgery between four walls”. It is measuring the “inaccurate mind with several pages of consecutive figures”. The problems must be seen as challenging - and exciting - and creative. This is where we must preach to the other group of converted - ourselves. The introduction of more innovative work early in courses, e.g. PBL could potentially engage and excite students while at the same time preparing them better for their careers. Innovation in engineering education
is much discussed at events such as this but we return to our universities and carry on as before. If we are to retain our entrants we must give them something to stay on for!

**Fig 2 Mapping of student expectations, university approach and industry’s needs**

**CONCLUSIONS**

We can, as in the Tao, try to wear away the mountain of public opinion with the silk cloth of our campaigns. In so doing we may persuade more able youngsters to join our courses - only to be disappointed in what they find.

We can change our courses to conform to the expectations of the majority of our entrants. In so doing we may find that neither industry nor the Institutions accept this as adequate preparations for the role of an engineer.

What I am suggesting is that we preach to the converted - and attempt also to convert the preachers. It is surely essential that the majority of our entrants should have a more realistic image of the nature of the role of the professional engineer. Certainly this may dissuade some from progressing, preferring instead to become technicians. On the other hand it seems likely that some to whom the "dirty hands" image had been unattractive will find the more realistic image more glamorous. We should, also, however, as academics recognise that (a) our courses do not greatly resemble the functions performed by a professional engineer and that (b) the majority of graduates find their role exciting and challenging. By reflecting these functions in our courses we might both better prepare our graduates and by exciting our students, go some way towards resolving our retention problems.

**References**


