Women, Men and the Practice of Engineering

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***Abstract**: The discussion of female representation in engineering has been stalled for some time at the stage of recognising that the culture of the profession is a contributory factor. Exactly what it is about the culture or what can be done about it remains unclear and discussion tends to fall back on work/life balance issues and family friendly policies in a way that focuses once more on women and their perceived problems. This paper draws on existing studies to suggest some ways of understanding engineering culture. A significant problem seems to be restricted definitions of 'real engineering' as an exclusively technical practice. Emerging research is confirming the common sense perception that much of engineering practice draws on technical knowledge to co-ordinate other people's activities. Paying more attention to this kind of reality of engineers' roles in industry has implications for recruitment, reward and retention of both genders in the profession.*

Introduction

Engineering is notorious as the only one of the traditionally male professions not to have reached a gender balance in the wake of second wave feminism and its attendant interventions and reforms. In Australia only 5% of the engineering profession are women, although female enrolments in engineering faculties runs at around 16% (Institution of Engineers 1996). A recent study (Burrows 2006) suggests that there may have been a peak in 2000-2001 and that we are now seeing a slight decrease in female participation. What accounts for this situation? There have been two ways of thinking about women in engineering; what needs to be done to help women fit into the profession, and what needs to be changed in the profession for women to find it attractive. Both approaches have the obvious disadvantage of essentialising both genders in terms of a narrow range of aptitudes, interests and career aspirations. Stereotypes are brought into play that portray women as more socially and environmentally sensitive with greater communication and teamwork skills than men. The failure of standard interventions almost certainly has something to do with the inadequacy of such understandings. But I want to propose that there is another essentialism in play which contributes to the gender imbalance of the profession, and reported high rates of attrition generally – the essentialising of engineering. For those inside and outside the profession alike, it tends to be defined as being largely heavy, dirty technical outdoor work despite the fact that everyone is aware of how much communication, people management and co-ordination is involved (Trevelyan 2007). For practitioners 'real engineering' is the heroically technical while all of the co-ordination is downplayed as of no professional significance, not 'real engineering'. There is ordinary gender discrimination in engineering as in other walks of life, but I want to focus for a while on how the paradox of "real engineering" complicates gender imbalance and stymies efforts to address it.

A concern with what engineering is and what it is not can be traced back as far as 1903, as this quotation shows:

> We have the man who fires the boiler and pulls the throttle dubbed a locomotive or stationary engineer; we have the woman who fires the stove and cooks the dinner dubbed the domestic engineer, and it will not be long before the barefooted African, who pounds the mud into the brick molds, will be calling himself a ceramic engineer.

cited in Pursell 2001

Historically, in order to position itself as a profession with associated social status, engineering has emphasised its use of science and the development of advanced technology as defining features. But, as we know, much of engineering practice is a matter of technical coordination (Trevelyan 2007) and people management (Fletcher, 2001; McIlwee and Robinson, 1992). Engineers commonly move into jobs they consider to be 'management' within a few years of graduation and also commonly refer to their role in such jobs as 'not real engineering'. And yet no engineer I have interviewed has ever told me that the engineering training they received was irrelevant to their jobs. They need to be engineers to do the job, so why isn't it regarded as 'real engineering'? In what follows, I want to suggest that this reluctance to pay attention to what actual engineering practice is results in a situation where students are recruited into the profession on what may be mistaken premises and where practitioners may find that vital parts of their practice is invisible, unrewarded and leaves them feeling equivocal about their role. As we shall see, there are reasons why this is likely to affect female engineers more than males, but the possibility of profession-wide implications cannot be ignored and needs consideration when there are calls, as now, for greater integration of industry, teaching and research.

Real engineering, recruitment and university life

With the movement of more women into the paid workforce in the 1960s and the advent of second-wave feminism, attention began to be paid to the difficulties women experienced in creating careers in the professions. At this time there were practically no women in engineering. In the 1970s and 1980s measures were initiated to increase female participation, mainly using a liberal policy framework emphasising equality and justice within the system. Girls were encouraged to take up high school subjects that allowed entry into the professions, were encouraged to enter into schools of law, medicine and engineering and benefited from a range of programs to keep them there until graduation. The dramatic increase of female engineering students from 3.3% in 1980 to over 13% in 1994 has been attributed, at least in part, to the success of such measures (Roberts & Lewis, 1996). But whereas female participation in law and medicine has continued to increase, engineering has stalled, with a decrease from a high of 21% back to 16% in the last two years at our University (see also Burrowes, 2006). This lack of female engineers has been most marked in Australasia, with noticeably higher female participation in countries such as the UK, USA, Canada and Sweden, and much higher participation in the developing countries and the former Soviet states. The low Australian participation rates in the graph in Figure 1 are caused by low numbers of female enrolments and a very high attrition rate post graduation, since around Australia, retention rates for women in engineering at university are as good as those for males (Hobart, Young, Mills and Gill, 2006).

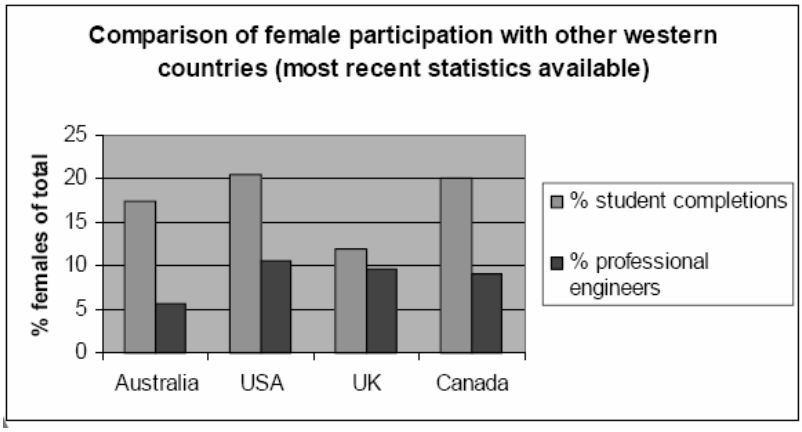

Figure 1: Female participation rates. Source: Engineers Australia website (http://www.engineersaustralia.org.au/about_us/sig/wie/res/publications)

To date, advertising for engineering courses has done little to affect these figures and I am suggesting that the mismatch between notions of 'real engineering' and the reality of engineering practice may account for this. Let us consider first the bases on which women are recruited into engineering.

Women are underrepresented in maths and sciences in the senior years of high school and engineering has not typically been something they have considered as a career. Suitably qualified women are encouraged to consider engineering as a career only relatively late in their education, in some cases as late as the last semester before graduation from high school (Hatt, 2007). They typically get this encouragement on the basis of good grades in maths and sciences and at University they are likely to excel since these subjects make up much of the University curriculum. A typical slogan on Women in Engineering websites is "are you good at maths and physics?" – implying that only those who are good at these subjects should apply. Of course the emphasis on maths and science sets all students up to expect that their professional practice will include a lot of technical calculation and there is evidence that the reality of everyday practice does not live up to such expectations, particularly in Australia, where industry does not support a large R&D sector. For women, doing well in maths and sciences in high school is more significant because they typically only enrol in these subjects if they have higher than average abilities in them (Hatt 2007) and this necessarily limits the numbers of women entering the profession. In contrast boys are more likely to feel comfortable about choosing engineering when their maths and science grades are ordinary. This emphasis on outstanding achievement can also be seen in much of the promotional material for women in engineering. While generalised posters and publications for particular courses and divisions are more likely now than previously to include women in the images used, those targeting or celebrating women specifically tend to focus on the trail blazing women of outstanding achievement (Hatt 2007, McIlwee and Robinson, 1992). This has been reported to be deeply off-putting to some women. While male students have told me that they feel that their university education has prepared them for a research career that is neither available nor wanted by most of them (Jolly 1998), women struggle to just fit in. It is common for them to avoid anything that explicitly addresses gender; they don't want to stand out, they don't want to have to prove anything on behalf of all women and they don't want to be treated differently.

But once women enrol in engineering courses, how does their experience prepare them for the professional workforce? While there may be debate about how well University training prepares anyone for actual engineering practice, there is certainly one fundamental facet of the profession that students do acquire: the tenet that there is a 'real engineering' and that failure to conform to the prescribed behaviours potentially disqualifies one from the profession. For students, 'real engineering' encompasses not only the technical skills already alluded to, but also certain attitudes, work habits and social behaviours which turn out to be heavily gendered (Downey and Lucena, 1997; Jolly, 1996; Jolly 1998). While there is no doubt that the majority of engineering students are working very hard they also work hard at conveying the impression that they don't really care about the work (which may be an Australian trait). Paper plane throwing in lectures and other disruptive behaviours demonstrate this and are matched by attitudes that all assessment or study is left to the very last minute and then completed in an all-nighter. Competition prevails over collaboration and social behaviours include a reputation for being the hardest-drinking cohort on campus (Downey and Lucena, 1997; Jolly, 1996). All of these behaviours are characteristic of what has been called hegemonic masculinity, that set of behaviours characteristic of some dominant males by which they maintain their dominance, so how do female students cope with them?

Female informants in my ethnography of first year students recognised this syndrome but were disinclined to challenge it. They said things like "You just don't take any notice of the shit they give you constantly" and "you've got to be bigger and badder than them" (Jolly, 1996) – a new take on the old saw that women have to be twice as competent to be seen to be half as good. While it may be that these male behaviours do not have much effect on the women, they are certainly learning that there is only one pattern for an engineer and no room for challenge. When I presented the first year ethnography to the academic board there was sufficient evidence of practices that were in contravention of both University policy and State law (Qld Anti-Discrimination Act 1996) but there was never any suggestion that action would be taken. Nor would the women who suffered from it make any move to stop it. Many times they were prepared to tolerate or ignore it but even when upset by it they would not retaliate. As we shall see, this pattern is repeated in industry with the CREW report (Mills et al 2002) stating that 50% of employed female engineers suffer some form of discrimination or harassment but it is easier for them to just move on to another job than to try to buck

the system. At least part of the reason for this, I will suggest, is that on average women find it more difficult than men to conform to the very narrow definitions of what constitutes 'real engineering'.

Real engineering practice

Some engineers argue that the current participation figures represent the best that can be done. They say that no more women are ever going to be attracted to the profession and in the current state of affairs that seems to be likely. But in a time of national skills shortage, there is an external prompt to renewed efforts to recruit more women. One way of doing this has been to argue that women have a special contribution to make to the profession because of their (learned or inherent) relational skills and diverse "approaches". All the while the work of coordination is not recognised as 'real engineering' those who have such skills cannot be real engineers. Since the stereotype is that this is women's forte, female engineers find themselves caught in the bind of being expected to be interested in and good at what Joyce Fletcher has called 'relational practice' whether they are or not and then likely to be thought lacking in core technical expertise. However, the reality of women's supposed special contribution, whatever that may be thought to be, is hard to demonstrate and most such arguments lack any empirical evidence. The following quote from a NSW government publication is typical:

> The NSW Government and information technology sector need the diversity of skills and approach that women offer. …[in a] wide range of IT jobs — [in] the forefront of extremely rapid technological change, and are developing IT-based systems to meet the needs of the NSW community, business and Government.
>
> http://www.eeo.nsw.gov.au/women/stories/change5.pdf

In other words these women are regular engineers. This is not surprising. It has been well demonstrated (Xiang-Yung Du, 2006) how unlikely it is that anyone going through a standard engineering education can come out other than a standard engineer (this is true for any education to some extent). To argue that they will do the job differently because they are female falls back into essentialising women as the nurturing, caring, relational against the male effective, instrumental, competitive. Because all of these qualities appear in both sexes, this argument is always going to fail, but in engineering it is difficult to find value for what are called the soft skills no matter who performs them. The stereotypically female qualities do not fit with the culture of a profession that sees its real work as technical and tough even when its not, and has trouble seeing the value of anything else.

We need to move beyond essentialism, and this includes stopping the practice of focussing gender discussions on women rather than on practices. For instance, family friendly policies are often articulated as though only women have families and this is often cited as cause of their attrition from the profession (as though women in other professions do not have these issues). Mills et al (2002) found that although accommodation to family demands is often cited *by others* as a problem that women in engineering have, it is rarely cited by the women themselves. As one senior female engineer in their study said " …I think if there wasn't another reason behind it you'd find a way around that one." Rather than address the real reasons behind workplace problems, whatever they are, women's assumed special needs and skills get invoked as an easy explanation. This could be an instance of the tendency noted above for women in engineering to not want to be singled out as different and having special needs, but Mills et al's study suggests that we need to more about what is actually happening. As increasing numbers of analysts are pointing out (McIlwee and Robinson 1992; Taylor 2006) we won't be able to address issues of women in engineering without undertaking cultural analysis and intervention in the profession. But cultural change is slow and difficult. Is it really necessary, and if necessary, is it possible?

Implications for the future

There are a number of external pressures which the profession may have to consider in answering this question, but the current national skills shortage is not one of them. While it is contributing to efforts to attract more people to the profession, and therefore turning recruiters' eyes towards previously untapped female populations, it is not in itself a reason for the profession to change in any way. Quite

the reverse. But there are indications that industry and society more widely are increasingly interested in having engineers move the work of coordination into a more central position in their practice.

Figure 2: Client ratings of consultant services. Source: 2007 Professions Study, Beaton Consulting

The 2007 Profession Report, produced with the support of a range of professional organisations including Engineers Australia, records that of all the professions, engineers are least likely to be rated as 'excellent' by their clients (Figure 2). There is evidence in this same report that one of the reasons for this is insufficient or inadequate communication. While clients can't go to other professions for engineering services, any engineering firm that provides better service could expect to have a market advantage that ought to be a spur for them to pay attention to their coordinating practices. Findings such as this chime with the demands of employers around the world for university graduates to have better training in skills such as communication and teamwork. UK research concludes that employers want graduates who help them deal with change and this has a large customer and people management dimension. There would seem, then, to be a business case for engineers to consider themselves as coordinators as well as technical experts. But in some industries, if self-interest isn't enough to drive change, legislation and the contract environment may have the same result.

In a recent study of the construction industry (Jolly *et. al.*, 2006) I had the opportunity to examine the emergence of a new role for the design manager which exemplifies the problems surrounding the recognition of coordination work in this changing legal environment. In the traditional, "designer-led", projects consultants manage the design. They work with the client to develop the requirements and the design while the contractor is concerned primarily with construction of a predetermined design. Such projects usually involve a win-lose ethos through the adversarial and confrontational attitudes that have shaped the industry. New procurement methods such as alliance partnering, BOOT schemes (Build, Own, Operate and Transfer) and Design and Construct contracts are based more on collaboration and partnering between client, consultants, contractors and facilities managers (Crane *et al.*, 1999; Cheng *et al.*, 2000) and crucially, the constructor's responsibilities do not end at hand-over. This has led to the emergence of a new kind of design manager within the construction setting; someone whose main job is the maintenance of design integrity through liaison of competing interests and points of view – very much a coordination task. But the company we studied had trouble managing, rewarding and integrating such a role in existing procedures. Few of the young engineers we talked to were keen to take on this role and they said they saw it as peripheral to 'real engineering' and, as one said, "I won't make MD by that route". Given that effective design management can make substantial improvements in the profit margin (Thiess 2002), there would once again appear to be a case for an expansion of the concept of 'real engineering' in the minds of practitioners and those who employ them.

How is such a shift to be attained? To suggest that employing more women would improve the profession's performance on such co-ordination tasks would be to fall back into the essentialism I want to avoid. But if the profession could find ways to value what it actually does over a stereotyped and narrow vision of itself, it may well bring about changes that would ultimately attract a more diverse workforce.

"There is little reason to believe that existing cultural norms are necessary to the pursuit of excellence in science and engineering" (Mack 2001:160).

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