2008

The New Engineer: Between Employability and Social Responsibility

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Recommended Citation

Conlon, E. (2008). The New Engineer: Between Employability and Social Responsibility. *European Journal of Engineering Education*, 33(2), pp.151-159.

The New Engineer: Between employability and social responsibility

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Abstract

The reasons behind the demand for what is sometimes called the New Engineer are critically examined and it is argued that a focus on employability alone is not sufficient to prepare socially responsible engineers. By examining issues around work organisation and sustainability it is proposed that engineers need to understand the wider social context in which they work. It is argued that the focus of ethics education should be broadened to focus on the social structure and the way it both enables and constrains socially responsible conduct. There is a call to refocus engineers' attitudes towards the systems of regulation so they see them not only as constraints but as potential enablers supporting socially responsible engineering.

Keywords: New Engineer, social responsibility, employability, social sciences, agency/structure.

1. Introduction

Given the demands for a broader education for future engineers 'it seems justifiable to speak of a general crisis in engineering education calling for 'a new engineer', (Christensen *et al*. 2007: 13-4). The 'New Engineer' will be a broad based professional who is socially and environmentally responsible (Beder 1998: x).

The demand for the 'New Engineer' is reflected in changing approaches to the accreditation of professional engineering programmes. Like professional bodies in other countries, Engineers Ireland (EI), previously known as the Institution of Engineers (IEI), has changed accreditation criteria to include outcomes focused on ethical standards, responsibilities towards people and the environment, teamwork and communication. Programmes are required to develop an awareness of the social and commercial context of engineers' work and the constraints that arise from that context. (IEI 2003: 11-12, 15-16).

This article critically examines how engineering education can adequately address the demands that are to be imposed on future engineers. It argues for the importance of the social sciences in helping engineers understand the context in which they will work and how it both constrains and enables their capacity for social responsibility. In this paper social responsibility will be understood as involving a commitment to a socially just, equitable and sustainable world (Pritchard and Baillie 2006). I will argue that a focus on employability alone will not equip engineers to be socially responsible because it fails to problematise the current structure of work and society.

I write as a sociologist concerned to highlight the role of sociological insights in helping engineering students achieve an understanding of the norms and intuitions required for social responsibility. Societal barriers to social responsibility appear to have grown in recent times with a key feature of current trends being the 'privatisation of everything' (Burowoy 2004: 263) including basic resources such as water. In an unequal world where interests conflict (between the developed and developing worlds, between the rich and the poor and between workers and employers) educators need to ask themselves who are they producing knowledge for and what will be done with this knowledge (Burawoy 2004) and engineers need to reflect on the kinds of problems they choose to solve and the criteria used to solve them (Johnson *et al.* 2000a: 315).

These points will be elaborated by examining the reasons proposed for creating the 'New Engineer'. These reasons include concerns about the social skills of engineers (Section 2) and, secondly, about the role and perception of engineering in society (Section 3). In Section 4 I will state my conclusions and make some proposals.

2. Engineering skills and employability[1]

Under this heading two interrelated reasons for change can be identified (Batley 1998, Bodmer *et al.* 2002, Palmer 2003, Markes 2006, Scott and Yates 2002). Firstly new skills are required to make engineers more effective as engineers and secondly, many engineers become managers or spend much of their working lives on management and supervisory tasks. This literature highlights the importance of acquiring non-technical generic competencies in areas such as communications, project management, leadership and teamwork, rather than the acquisition of theoretical knowledge in a range of 'socio-economic' subjects.

This emphasis on generic professional practice skills is not surprising given the changes in the organization of work resulting from increased global competition. Features of the 'new industrial paradigm' (Christensen *et al*. 2007:19), include: total quality management; new forms of work organisation with an emphasis on team work; flexible production systems and employment contracts and a focus on customer needs.

This new orientation requires new skills. In a sense engineering educators are being asked to prepare graduates to insert themselves in the flexible globalised workplace:

> the focus of training must increasingly be on *employability* and that there is an urgent need for a concerted effort… to ensure that a well-trained flexible workforce is available as a means of sustaining a national competitive advantage in a world of megacompetition. (Richardson 2000: 179, emphasis added).[2]

[1] Employability has been defined as *'a set of achievements – skills, understandings and personal attributes – that make graduates more likely to gain employment and be successful in their chosen occupations.'* by the UK Higher Education Academy, Engineering Subject Centre. See http://www.engsc.ac.uk/er/employability

[2] This purely economic view of globalisation is reflected in the accreditation documentation of Engineers Ireland which requires students 'To understand and contend with globalisation and its impacts on the marketing and manufacture of product'(IEI 2003:16).

It is also the case that engineers are being asked to be agents of globalization and advocates of new organizational forms. For example, Devon (1999) argues that Lean Production should be viewed in 'a positive ethical light'. Others have argued that 'modern approaches to quality management are starting to improve the quality of work for many employees' (Johnston *et al*. 2000: 138).

This optimistic view of modern work systems is problematic given engineers' responsibilities for the way work is organised for others, their role as originators of ideas about work organisation and the substantial evidence that the experience of work has not improved for those working in systems such as Lean Production (e.g Bradley *et al.* 2000). Ciulla (2000) argues that Reengineering, the last major management theory of the twentieth century, shares with scientific management a concern 'with the speed of production. Time is still money, only now it moves faster and costs more' (p.147) and while fairness is the central moral issue in the workplace, income inequality is increasing 'across virtually all the developed economies of the world' (Cappelli 2006: 472)[3]. A review of Irish evidence on workplace change in the 1990s concludes:

> the period since the 1980s has witnessed a regression in the quality of work life as many workers are expected to undertake increased workloads and experience intensification in the pace of work (without) an increase in their influence over day to day activities. (Gunnigle 1999).

The significance of this for social responsibility is that it raises questions about whose problems engineers are trying to solve and on what basis. In most cases engineers tend to be absorbed in management hierarchies and values and tend to use business considerations as appropriate criteria for engineering decision-making (see Meiksins and Smith 1996: 9). Johnston *et al.* (1996) have argued that the discourse of business (and science) has dominated engineering. They argue that while engineers are keenly focused on productivity they do not see the fair distribution of the benefits of economic activity as their concern. This focus on productivity is now to the fore and finds expression in the employability discourse.

Downey and Lucena (1995) note the rise, during the 1980s in the USA, of concerns about competitiveness, which elevated 'engineering to the status of a national problem,' (183). With globalisation this focus on competitiveness has grown worldwide and has led to a focus on the employability skills of engineers. There are increasing demands for education to be more responsive to the needs of industry but there must be concern that that this will lead to a narrow focus in engineering education whereby graduates are trained to insert themselves into the 'runaway world' (Legge 2006) of globalisation. Employability denotes the requirement to adapt to the demands of employment and for individuals to remain competitive in the labour market (Garsten and Jacobsen 2003:2). In this context students may end up believing that they 'are only responsible for themselves' (Winner 1998).

The employability agenda is about getting graduates to adapt to the new flexible workplace. Crucially, graduates skills are problematised while the employment practices of employers are left untouched: 'The skills identified as core produce the type of

[3] There is also evidence of rising global inequality (see Riley 2007).

knowledge and understanding that is required to maintain dominant cultural and political arrangements' (Morley 2001: 137). But a critical focus on these arrangements is required if the quality of working lives is to be enhanced.

A focus on employability skills alone will not give engineers the capacities required to reflect critically on the structure of work and the manner in which the rewards of productive activity are distributed. It will not force them to ask questions about whether the work they design for others provides 'opportunities for workers to realise their human potential through creative, meaningful, and productive work' (Legge 2006: 310). [4]

A sociological approach to work emphasises the inequality inherent in the employment contract, the conflicting interests and asymmetry of power of the parties (Brown 1998). It focuses not just on the workplace but also on the wider social arrangements, which constrain or enable the power of workers and employers. This focus helps us understand why the quality of work may vary across different societies.

For example, Meiksins and Smith's (1996) comparative study of engineers considers the experiments in work humanization in Sweden. They argue that:

> Conditions in Swedish society have imposed on engineers more constraints, and created the conditions for a dual agenda for production efficiency and work humanization' (265).

What can be noted is the manner in which constraints become enablers for work humanization. Important factors in the Swedish case included societal commitments to full employment, which led to tight labour markets, and egalitarianism, a comprehensive welfare system and the strong position of trade unions with a wide membership base (including many engineers) and comprehensive legal rights at the workplace. This means we have to consider the regulatory environment, and the way it can shape the balance of power at the workplace, at a time when globalisation is promoting lightly regulated labour markets.[5]

Meiksins and Smith also argue that work humanisation was facilitated because Swedish engineers were closely aligned with manual workers and were engaged in a dialogue with social scientists 'exposing engineers in their training and practice to the benefits of work humanization' (1996:265).

What the above example suggests is the importance of engineers being exposed in their education to criteria other than narrowly conceived productivity, efficiency and flexibility, and the importance of them understanding the wider social context of their

[4]It is hard to find treatment of issues related to work design in engineering ethics textbooks. Even Goujan and Dubreuil (2001),which is broad ranging in content, does not deal with the topic in any depth. In a SEFI document from 1995 on *Educating the Whole Engineer* it is suggested that industrial sociology is a 'vital technical subject' (p.3). This is problematic in that it suggests that work design is a matter of the application of technology. But a broader view is necessary if we are to develop work systems in which the humanity of the people who work in them is recognised.

[5] Further evidence for the importance of the regulatory environment can be found in Lorenz and Valeyre (2004). They examine different work regimes across the EU 15 and show that deregulated labour markets, especially in Ireland and the UK, do not provide the necessary institutional support for establishing substantial forms of autonomy at work.

work, including the regulatory environment, and how it enables or constrains the possibilities for designing meaningful work for others. A focus on the wider social context is also required if engineers are to contribute to creating a sustainable society.

3. Engineering and society

The second set of reasons behind the demand for the 'New Engineer' focus on the relationship between engineers and society. There is concern that the status of engineering is being undermined as engineers are identified with environmentally damaging technologies.[6] There is particular concern about the failure to attract women into the profession. To attract women, the humanitarian role of engineering should be highlighted including the role of engineering in promoting sustainable development.

3.1 Sustainable Development (SD)

There is increasing pressure to practice engineering more sustainably. The mission statement of Engineers Ireland , along with the Code of Ethics, contains a commitment to the promotion of SD. Engineers are seen to have a key role in making economic and technological activities sustainable and some have argued that engineers are uniquely placed to take a lead in moving towards sustainability but only if 'they have a broad understanding of their own discipline and an awareness of how it fits with other disciplines and into the social fabric of their society' (Johnston *et al.* 2000: 316). The evidence suggests that engineers tend to have a narrow understanding of the concept.

SD focuses on the relationship between 'three pillars': the ecological, social and economic, yet many commentators have highlighted the failure of engineers to grapple with the social dimension of SD (Herkert 1997, 1998, Johnston 1997, Szymkowiak 2003). Turek and Mistina claim that 'engineering education takes a prevailing technocratic approach, aimed especially at maximising production and economic efficiency' (2007: 397). Again the failure to address issues of distribution can be noted (Johnston 1997).

This approach to SD seems to be reflected in engineering students' understanding of SD. Research with students (Carew and Mitchell 2002, Azapagic *et al*. 2005) suggests there are substantial knowledge gaps across all stages of engineering programmes. Students appear to be relatively knowledgeable about environmental issues but significant knowledge gaps exist with respect to the other two components (social and economic) of

[6] It is true that there have always been engineers who are concerned about the social impact of engineering irrespective of concerns about the image of the profession. But recent research on the image of the profession does highlight the importance of the societal impact of engineering. For example a recent report from the UK Royal Academy of Engineering on *Public Attitudes to and Perceptions of Engineering* states: 'The social responsibility of engineering is an important issue underpinning attitudes towards the profession' (p.38). See http://www.raeng.org.uk/news/publications for the full report.

SD. There is clearly a need for students to embrace a fuller understanding of SD including the social and economic dimensions.

Even then problems remain in moving towards sustainability (see Donnelly and Boyle 2006). Taylor (2005) has suggested that Irish environmental policy is constrained by the concern not to compromise the market ethos and the inward investment upon which recent economic growth was predicated. There are powerful vested interests opposed to the kind of radical change required to move towards a sustainable and just society. The very operation of free market systems encourages growth for growth's sake (Smith 1997) and overconsumption (Woodhouse 2001). This means that more fundamental questions have to be asked. Sustainability 'implies cultural, social and economic restructuring simultaneously with technological restructuring' (Donnelly and Boyle 2006: 150). Here again we see a focus on the wider context in which engineers work. Donnelly and Boyle highlight the importance of changing that context by changing the regulatory environment to favour sustainable solutions and outcomes. Current trends towards deregulation are contributing towards ecological devastation because the role of governments in correcting environmental externalities is reduced (see Riley 2007, Smith 1997).

Assuming the goal of sustainability and given the obstacles to moving towards it an (exclusive) approach to engineering ethics which focuses on the ethics of individual engineers must be questioned. This can be justified by looking at how sociology understands human action.

3.2 Engineering Ethics and Social Theory

Sociology is concerned with the relationship between social structures and human action (agency). The structure-agency debate is at the heart of social theorising (Carter and New 2004) and has increasingly focused on how social structures *both* constrain and facilitate agency.[7] Social structures can be seen as the rules of society but also the sets of social relations which provide differential access to material and cultural resources. A focus on social structures requires that we examine how social activity is organised, the manner in which social relations provide differential access to power, and the legitimating values used to maintain or modify these relations.

Engineering ethics is concerned with the values of engineers. The focus is often on the ethical behaviour of the individual engineer.[8] But in reality while engineers *may* be committed to ethical practices it is not always possible to behave ethically. Social theory suggests that the capacity to be socially responsible is not solely a feature of the values of actors. To exercise agency, commitment to particular outcomes *is* necessary, but so is the

[7] Most introductory text books in sociology deal with the structure/agency debate. A good introduction can be found in various editions of George Ritzer, *Sociological Theory* (Mc Graw Hill), which is now in its 7th edition.

[8] Bucciarelli (this issue) provides some examples.

power to achieve these outcomes. To exercise agency actors must have choices, but these are constrained by the physical world, the social structure and the power of other agents.

A key constraint identified in relation to engineering ethics is that most engineers are employees they do not have control over the projects on which they work. They tend to solve problems 'framed and formulated by others' (Johnston, *et al.* 1996). If engineers are to solve or diminish the ethical dilemmas they face and increase their capacity for social responsibility they have to understand the broader context from which ethical dilemmas originate and they have to play an active role in helping to reshape that context wherever that may be necessary (Zandvoort, *et al.* 2000: 297, see also Herkert 2006). The engineering profession

> must start working to influence the restructuring of current social, political, economic, and institutional paradigms…thus increasing the diversity of acceptable options and our ability to move in more sustainable directions (Donnelly and Boyle 2006: 153).

Two issues are crucial here. Firstly, engineers need to address the 'contradiction', highlighted 30 years ago by Mike Cooley (1978), of the gap between what technology could provide for society and what it actually does provide. Rather than simply promote globalised competition and conspicuous consumption engineers should promote economic activity which meets vital social needs.

Secondly, if we are to refocus engineering activity, and diminish some of the ethical dilemmas that engineers face in their daily activity, then it is vital that engineers and engineering educators move beyond seeing rules, such as laws and other regulatory devices, just as constraints but also as enablers that *may* facilitate socially responsible action. It is the case that engineers need good laws (Zandvoort 2005)[9] and need to engage in debate about the nature of these laws. They also and need to make alliances with those seeking regulations requiring sustainable and socially just practices. Engineers need to consider how they intervene in the public policy arena and whether these interventions enable or constrain the move towards a sustainable and just world[10].

This suggests that engineering ethics must focus on more than the individual ethical dilemmas faced by engineers. The requirement to widen the scope of engineering ethics,

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[9]Zandvoort (2005) has highlighted important areas for reform including the need for change in the rules of liability. He has argued for the need of strict legal liability in view of the responsible management of the environment, technological risks, and sustainability. (p 25) He is also concerned to promote the idea that laws can be solutions to prisoner's dilemmas. A law is a solution to a prisoners dilemma in Zandvoort's terms if the law makes each individual better off, at least in the long run, than would be the case without the law. Such a law could in principle be adopted with unanimity. Zandvoort appears to suggest (but does not explicitly state) that a transition from the current limited or fault liability laws to strict liability laws may represent solutions to prisoner's dilemmas, and hence might proceed on the basis of unanimity, as the effects of the transition may ultimately be beneficial for all. However, it can be doubted whether such legal change could be expected on the basis of unanimity. This latter requirement would seem to allow vested interests, mainly corporate actors, the opportunity to effectively block legal change which they oppose.

[10] In Ireland EI supported the government's Critical Infrastructural Act which aims to fast track planning processes and which 'may constrain future collective action on environmental issues' (Leonard 2000: 238). This is significant in the context of Leonard's assessment that it has been the combination of top-down EU legislation and bottom-up grassroots agitation that has shaped Irish environmental policy.

including a greater engagement with STS scholarship, is increasingly recognised and should be encouraged and developed.[11] A focus on the agency/structure relationship will help in integrating micro and macro issues in engineering ethics teaching by giving a focus to a number of key questions:

- What meaning does social responsibility have for engineers both individually and as a profession? Whose problems do they choose to solve?
- What criteria (e.g profit or need) do they use in solving engineering problems and whose interests do these solutions serve?
- What constraints stop them acting in a socially responsible manner? Do they have the power to act or does the power of others stop them?
- How can these constraints be changed to facilitate social responsibility? What changes in public policy, including laws, or social practices are needed and what resources and allies can they call on to help them seek these changes?

4. Conclusions and implications for the curriculum

It has been argued here that engineering education needs to widen its focus if students are to be educated as socially responsible engineers. A narrow focus on the skills and values of individual students related to employability is not adequate to prepare them for the challenge of delivering sustainable and just engineering solutions. Students need to develop the capacity to situate their individual practice as engineers in its wider social context. How is this to be done?

In his article Bucciarelli suggest a wholesale reorganisation of engineering education to broaden its focus and embed the social dimension in a multidisciplinary approach to engineering education. This can be endorsed but from an Irish perspective the extent of reform proposed is wide and unlikely to be realised in the short term[12], although discussions on moving to a full three plus two model to comply with the Bologna Accord will open up the possibility of broadening the early years of engineering courses. It also opens up the possibility of attracting more women to engineering (see Beraud 2003).

In the interim a number of priorities can be identified:

1. Engineers and engineering educators need to more fully embrace a commitment to social justice, equality, work humanisation and the principles of SD. These should provide the underpinning for all engineering programmes. Students should be introduced to these principles in the first year of their studies so that they come to see them as inherent to engineering and come to see engineering as a social as well as a technical process;

[11] Rather than provide a long list of references I refer readers to the following following: European Journal of Engineering Education **25** (4); IEEE Technology and Society Magazine Fall 2001 and Winter 2001/2; Goujan. and Dubreuil (2001) and Herkert (2006). See also Bucciarelli in this issue.

[12] In a recent address the President of one of Ireland's main universities has highlighted the emphasis on depth, rather than breadth, in Irish higher education which makes it hard for students to take options outside their chosen specialisation. See http://www.ul.ie/presoff/Inaugural%20Speech.htm

2. All project work undertaking by students should address explicit social criteria on which they should be assessed. Students should undertake project work with an explicit public policy dimension;
3. Engineering students could be offered modules in the social sciences including STS studies to help them understand the manner in which technology is socially shaped;
4. Given that many engineers study management these modules should address principles of work humanisation and the importance of redressing the imbalances of power inherent in the employment relationship;
5. Ethics modules should specifically deal with the obstacles inhibiting an ethical engineering practice and the public policy role of the engineering profession. Students should be given the opportunity to critically evaluate the public policy positions of the profession.

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Curriculum

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