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Engineering ethics: Ontology and politics

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Abstract: *“Ontology...acts as both gatekeeper and bouncer for methodology” (Archer 1995: 22). This exploratory paper, through a focus on the relationship between structure and agency, examines the underlying social ontologies informing the teaching, and researching of the teaching, of engineering ethics. It argues that current approaches are deficient and that Critical Realism can provide the basis for a more robust and inclusive research agenda for understanding engineering practice and the teaching of engineering ethics.*

Introduction

The relationship between human action (agency) and society (structure) lies at the heart of much social theorising (Archer 1995). In this paper I explore the teaching of engineering ethics (EE) through the lens of this relationship. I do this in order to draw out the underlying social ontologies informing approaches to this subject. The argument is simply that how we see EE will inform our approach to researching it. It will inform the questions we ask and the kinds of explanations developed to evaluate the integration of ethics teaching in engineering education. First, I outline a recent experience in participating in a survey of ethics educators in order to discuss the predominant approach to ethics teaching which is focused on the actions of individuals. I then explore some alternative approaches to argue firstly, that the focus in the literature on the need to integrate macro issues does not necessarily allow for an adequate integration of agency/structure relations in understanding ethical issues, and secondly, that some macro approaches effectively eliminate the possibility for ethical reflection by engineers. Finally, drawing on Critical Realism (CR) and the work of Margaret Archer, I argue that current approaches suffer from various forms of *conflationism* and that CR can provide the basis for a fuller integration of agency/structure relations in ethics teaching. It can also inform a research agenda which extends beyond the evaluation of the extent to which we prepare our students to resolve ethical dilemmas. In doing this I realise there is much debate in sociology about how to conceptualise the social structure and the relative importance given to cultural patterns and systems of social relations, which provide differential access to power and resources, in these conceptualisations (Porpora 1989). Space prevents full consideration of the issues here as my main focus is on the manner in which action is linked to the wider social environment broadly defined. However a supplementary argument is that when EE does attempt to incorporate the wider context the focus is often on culture rather than on social relations of power.

The Individualistic Approach

This paper was prompted by my participation in a recent international survey of EE teaching conducted by the Japanese Society for Engineering Education (JSEE). In the accompanying **Learning and Educational Objectives of Engineering Ethics Education** we find a strong commitment to what I have previously called the individualistic approach to EE teaching (see Conlon and Zandvoort 2010). The document states that the “the final goal of engineering ethics education should be to foster qualities and abilities that enable...engineers to make self-reliant/autonomous decisions and act according to their decisions as professionals.” It says that ethics education should develop the “Ability (i) to examine solutions from multiple viewpoints including resolving ethical dilemmas and demonstrating consideration to stakeholders' concerns and (ii) to determine the best solution plan applying comparative evaluation of options”. The document demonstrates a commitment to the individualistic approach. This approach uses case studies to focus on the resolution of ethical dilemmas by

individual engineers. These often involve clashes between engineers and managers and focus on the capacity of engineers to resist managerial pressures. The approach draws on moral philosophy and codes of ethics as the basis of ethical decision making. It assumes that not only can ethical problems be solved at the level of the individual but that engineers can act on their solutions. This approach frames the research questions in the Japanese research which focus mainly the importance of values, attitudes, responsibilities and problem solving. This is somewhat problematic in that while this approach seems to be the dominant form of ethics teaching (see Hess 2013, Colby and Sullivan 2008) many have called for alternative approaches which focus on the realities of engineering practice, the broad goals of engineering, policy issues and institutional arrangements which affect the practice of engineering (see Conlon 2011).

While there are references to the wider society in places on balance the document is focused on the individual engineer. By ignoring the structural context in which engineering takes place this approach leads to moralism as unrealistic expectations are placed on individual engineers (Swiestra and Jelsma 2006). The adoption of the individual approach by JSEE is even more surprising given that Shibata (2011) has argued that: "The most Japanese engineers belong to private firms. As a result, they cannot act individually and be an independent professional... Individual engineer's ethics, in other words micro-level engineering ethics, do not always work effectively for all Japanese engineers." (161)

But that is not the only problem. The JSEE document also states that the attitudes and values required of engineers "is neither to force nor to deny particular values, attitudes, or ideology on to engineers. Instead, it is intended to clarify and emphasize the role of engineering ethics education while maintaining respect for the diversity and the individuality of values, and to encourage learners to make autonomous decisions while remaining aware of their responsibilities and roles." This is a call for value neutrality and is based on the contradiction that while we want engineers to practice engineering ethically we do not seem to want them to commit to any particular set of values. Engineers are to strive for "creative middle ground" (Harris et al. 2009) solutions and EE teachers are to avoid preaching (Pfatteicher 2013). There would seem to be an assumption that not only are creative middle ground solutions desirable but also that they are attainable (in that the needs of all parties can be met) and implementable.

This commitment to political neutrality, the focus on the individual engineer and the bracketing out of the wider context are linked. The case study approach to EE "tend to focus upon relatively rare, narrowly bounded crises ... (The) contexts that underlie particular cases are never themselves called into question" (Winner 1990: 53-54). The assumption is that "as one enters a profession, one simply embraces the existing commitments, institutional patterns, and power relationships" (56). Thus this approach does not lead to the questioning of the wider purpose of engineering or the role of engineers in reproducing power relations and patterns of privilege in society. They are not encouraged to reflect on whose interests they serve as they practice engineering. Thus there is a crucial link between the ontological assumption that EE teaching should focus narrowly on the practice of individual engineers and the political assumption that ethical dilemmas can be resolved at this level without changing the context in which engineers work.

Responsible Engineers

The defense of the individual approach focuses on the "moral accountability of individual engineers" (Harris et al. 2009: 23) and the issue of responsibility (Davis 2006, 2012). Indeed codes of ethics, which play a central role in the individual approach, are essentially "standards of responsibility" (Harris et al. 2009:25). Davis opposes the tendency, as he sees it, of social theorists to eliminate the need to explain individual decision making by falling back on "social forces" to relieve engineers of moral responsibility for what they do. He claims engineers have the capacity to be morally responsible and can be held individually responsible for their actions. EE should help "engineers to take their professional responsibilities to

heart” (Swiestra and Jelsma 2006: 310) As a result, those using the individual approach tend to focus on individual failings as the key impediments to responsible action. Harris et al. (2009: 37-43) list impediments such as self-interest, self-deception, fear, ignorance, egocentric tendencies, microscopic vision and uncritical acceptance of authority. They identify one barrier which focuses on group processes, which is groupthink, but see it as a problem arising from the needs of individuals for high interpersonal cohesiveness rather than the outcome of an exercise of power (see Edward and Wajcman 2005).

There are two main problems with this focus on individual responsibility. One is that the practice of engineering involves collective activity and secondly, the conditions for assuming moral responsibility by individual engineers do not always exist (Swiestra and Jelsma 2006, see also Coeckelbergh 2006 and van de Poel and Fahlquist 2013). It is argued that the conditions (moral agency; causality; free will and knowledge of consequences) for assuming moral responsibility rarely exist in engineering practice. One particular problem is what is referred to as the “problem of many hands” in that engineers are just one of many actors involved in complex organisational and technical processes. Further, the freedom of engineers is restricted in that they typically work in “hierarchical organisations and have little room to follow their own choices” (Swiestra and Jelsma 2006: 314). This refers to what is known as the captivity of engineering to corporate and managerial agendas (Conlon 2013). Davis (2012) is somewhat dismissive of this idea in that he argues that engineers can break off their association with their employer at any time just by giving notice. There are many problems with this rather naive view of the employment relationship. From the perspective of engineering practices it might mean that even if the engineer breaks off their association with their employer this may not lead to questionable or unethical practices stopping. It can be noted, in this context, that Davis’s discussion of the rationale for whistleblowing is focused on the need for individual engineers to avoid complicity in doing harm rather than that stated by de George, which is to avoid harm (see Harris et al. 2009). Thus one can assume that if the individual engineer is not complicit then it may be okay not to blow the whistle on harmful activities.

The decision to view a risk as an individual or collective matter entails different strategies for dealing with risk reduction (van de Poel and Fahlquist 2013). This is why some have called for a focus on institutional ethics rather than individual ethics. Underlying this work is the recognition that “If the engineers claim for safety have to survive in a context dominated by competition for money and power, regulation with an ethical content may be the engineers life jacket” (Coeckelbergh 2006: 250, see also Zandvoort 2005).

Macro/ Micro or Structure/Agency

This call for a focus on institutional ethics is one of a wide variety of proposals to refocus the teaching of EE. I have previously (Conlon 2011) tried to map out these approaches and their relationship with the individualistic approach by focusing on the call for the integration of macro issues into EE (Hekert 2005). This exercise was useful in helping to delineate the differences in approaches to EE teaching but it also highlighted the limitations in the call for a macro approach, in that this call may focus solely on the “macro subjective” dimension by focusing on the collective goals and culture of engineering without taking adequate account of “macro objective” factors, such as power relations, which shape the institutional environment of engineers.

For example, Bowen (2009), who is critical of the individualistic approach, calls for an aspirational ethics and a focus on the aims of engineering. He argues for the promotion of human flourishing, that engineers have not engaged sufficiently in ethical analysis of their activities and they need to take responsibility for the outcomes of their activities. An aspirational approach will stimulate a change so as to promote the personal ethical responsibility of every engineer. A person who “genuinely possesses a virtue would be expected to manifest it through the range of his or her activities” (p.79). Bowen’s approach is useful in reminding engineers of the importance of prioritising needs. But it not clear that he

offers a clear path to address the failure to prioritise human need as he does not adequately take account of the specifically capitalist context in which much most engineering takes place and its tendency to commodify all social relations such that they become purely instrumental (Moriarty 2008). There is no discussion of power in Bowen and no engagement with the captivity of engineering. The main emphasis for Bowen is on the culture of engineering and the development of an aspirational ethos amongst engineers. His emphasis is on the collective goals of the profession (a macro issue) but not necessarily on the structural context in which engineers work. His approach remains focused on the agency of engineers.

The other problem with the macro/micro distinction is it is not always easy to distinguish the micro from the macro as they are intertwined and depend on each other (Layder 2006). Herkert (2005) has, for example, identified the design of safe products as a micro issue. But the safety of engineering products and processes is affected by the attitudes, practices and organisation of engineers, organisational structures and culture, the regulatory regime, production pressures and public policy, which includes policy on product liability which Herkert identifies as a macro issue. It would seem then that the key issue is not just the scale of the issues which EE teaching addresses but how different mechanisms come together to produce particular effects on the practice of engineering. This involves looking at how the practices of engineers impact on and are impacted by their social environment. This calls for a more sociological approach to understanding engineering practice. But this call is not unproblematic. Davis (2006) argues that sociological approaches to EE tend to make decisions seem inevitable as events are seen as linked by social forces rather than by individual decisions. And there is validity to this critique as some forms of sociological explanation treat humans as oversocialised “cultural dopes” who merely manifest the demands of their society. If actions are determined at this level then all ethical issues are diluted as human resistance and intervention become futile (Reed 2005: 296).

The Challenger Challenged

There is a tendency to such an approach in the much praised account of the Challenger Disaster by Diane Vaughan (1996). Her approach is seen by some to offer the basis for a clear alternative to the individual approach in its focus on the practice of engineers and the organisational and cultural context of that practice (see Bucciarelli 2008 and Lynch and Kline 2000). In explaining the disaster she emphasises *institutional logics* and the manner in which patterns of behaviour developed and became institutionalised within the organisations supporting the Shuttle programme.

Vaughan discusses how risk came to be redefined, leading to a number of launches with a flawed design and the “normalisation of deviance”. She highlights the wider economic and political environment in which NASA operated and the way it contributed to the the normalisation of deviance. Changes in NASA’s budgetary environment meant that “schedule, budget, following rules and procedures, and allegiance to hierarchy displaced safety and deference to the expertise of working engineers” (Vaughan 2008: 74). Thus she not only focuses on the organisation and work groups but at the relationship between the culture of the workgroup and the wider economic and political environment. She is sceptical about the possibilities for organisational reform which does not take account of this wider environment (1996:415-22).

While being a useful corrective to the focus on individual engineers this seems to argue for too neat a fit between the wider culture, the organisational culture and the behavior of individuals. As she says: “The NASA case showed how sets of organizing assumptions institutionalized in the organization field trickled down through layered structures...shaping individual cognitive processes and actions... At the micro-level, they created a way of seeing composed of shared understandings about risk, how the work should be done, and the criteria for decision making” (Vaughan 2008: 74).

What is significant, for the argument being developed here, is that Vaughan's account draws on particular theoretical approaches, *new institutionalism* and Bourdieu's concept of *habitus* (Vaughan 2008), which tend to emphasise the determining role of social structures at the expense of human agency. At the most general level Vaughan relies on new institutionalism to argue that the institutional context gave rise to a culture of production that led to a defective decision making process (Feldman 2000). Her use of this approach leads to an emphasis on the integrating role of the organisational culture: the stress is on the unreflective and routine (see Powell and DiMaggio 1991: 10 and 14).

This focus on the taken-for granted and unreflective nature of action is reinforced by her use of *habitus* to demonstrate how the institutional forces in the organisational environment become embodied in the actions of the engineers. *Habitus* refers to the "set of dispositions inculcated in each of us by the conditioning that follows from our social environment" (Elder Vass 2007: 326). These dispositions are durable and shared by those holding similar positions in the social structure: the inculcation of a *habitus* leads to "the internalisation of the principles of the social structure" (Burawoy 2012: 190). Through the operation of *habitus* people's practices are beyond conscious mastery and each of us "wittingly or unwittingly is a producer and reproducer of objective meaning" (Bourdieu 1977: 79). Proponents of new institutionalism have seen it as a key concept for linking macro social forces to behaviour "to explain why strategically orientated actors *chronically reproduce and acquiesce* to social structures that are not in their interest" (Powell and DiMaggio 1991: 26 emphasis added).

Bourdieu developed the concept in an effort to overcome the opposition between structuralism and constructivism (between society and the individual) in social theory. His focus is on *practice* and the dialectical relationship between agency and structure (Bourdieu 1977). While he seeks to bridge the gap between structuralism and constructionism he has a bias in the direction of structuralism. This leads to two related problems. Firstly the notion of *habitus* leaves little room for human reflection and intentionality: *habitus* is merely a conveyor belt for the determination of action by social forces (Elder Vass 2007). His model of practice "turns out to be a celebration of mindless conformity" (Jenkins 2002: 97). This leads to the second problem in that if there is no room for agency there is little possibility of change, protest or resistance (Jenkins 2002, Burawoy 2012).

It is no surprise then that Freeland (1997) claims that Vaughan veers too far towards an "oversocialised" conception of action "in which actors passively reproduce learned cultural scripts" (131). A key criticism of her account is in focusing on the institutional culture she neglects the issue of power: "she replaces the study of conflict with a notion of totalising and unconscious institutional forces" (Feldman 2000: 476, see also Perrow 1996). In fact the launch decision, which led to the disaster, took place under unprecedented cold conditions outside parameters that had not been previously investigated. Thus it was not normal. If universal macro forces were dominant disagreement could not have arisen. The launch was opposed by a group of engineers who knew it was outside normal parameters, rather than being embedded in an unquestioned culture (Edwards and Wajman 2005). In effect she is offering a particular kind of sociological explanation, with the emphasis on the organisational culture, which does not take adequate account of the capacity of people to challenge dominant cultural scripts.

But this is not the only kind of sociological explanation. Some social theory has sought to deal with the question of human agency and the manner in which actors develop the capacity to influence their environment. It is the case that human choice is restricted and confined by social and cultural structures. But these structures can be changed to enable actors to have greater choice. Archer has argued that the key issue facing social theory is to develop frameworks that specify the conditions "under which agents have greater degrees of freedom or work under a considerable stringency of constraint" (Archer 2000:6) Archer is a proponent of critical realism (CR) who has sought to provide an account of the agency structure relationship which takes account of a properly argued view of both and the relationship between them (Scott 2000). This can provide the basis for a more robust and inclusive

agenda for understanding engineering practice (Kotta 2011), the teaching of EE and the researching of that teaching.

Critical Realism

CR has emerged as an alternative paradigm in the social sciences to positivism and interpretivism. It combines a realist ontology with an interpretive epistemology: the real world exists independently of our knowledge of it and our knowledge of the world is always fallible as it is shaped by the “social position of knowers and theories on which they draw” (Carter and New 2004: 2). CR argues for the primacy of ontology but also that the “nature of what exists cannot be unrelated to how it is studied...the social ontology endorsed ... conceptualises social reality in certain terms, thus identifying what there is to be explained” (Archer 1995 pp. 16-17). Thus what society is held to be, including how we understand the relationship between structure and action, affects how it is studied and what constitutes “explanatory purchase on substantive social problems” (12).

In seeking to explain social phenomena CR offers a distinctive approach (Scott 2007, Carter and New 2004). It is not possible to deal with all aspects of it here but two issues are important for the purposes of this paper. Firstly, CR offers a depth ontology: a notion of a stratified reality which includes a distinction between the domain of the real (generative mechanisms), the actual (events) and the empirical (experiences). Structures of objects at the level of the real generate mechanisms that facilitate events. CR focuses on the identification of these mechanisms as causal factors explaining social phenomena. This is potentially emancipatory in that it forces us to consider “that certain states of affairs cannot be ameliorated within existing structures”.(Collier 1994: 10). They must be changed.

Secondly, structures are described as generative mechanisms, because when their powers are realised they work to make things happen. Their activation is dependent on human agents. CR is committed to an explanatory model “in which the interplay between pre-existent structures, possessing causal powers...and people possessing causal powers...of their own results in contingent yet explicable outcomes” (Carter and New 2004: 6). This implies that any investigation can only take place “at the intersection...of agential and structural objects” (Scott 2007:15). Archer (1995) argues that social theory has come up with unsatisfactory ways to understand this relationship and she provides a framework for understanding different approaches by focusing on what she calls varieties of *conflationism*. On the one hand there is downward conflation which emphasises the determining effect of social structures and allows very little role for intentional human activity in explaining social forms. On the other hand there is upward conflation which places undue emphasis on the creative and intentional dimension of human activity and downplays “the way human beings are both immersed in and constrained by the way society is constructed” (Scott 2000: 28). She identifies a third kind of central conflationism, evident in the work of Bourdieu and the sociologist Anthony Giddens, which see agency and structure as “mutually constitutive” and fundamentally inseparable. Structures are instantiated in social practices and are not seen as constituting externalised entities that constrain agency in various ways. Thus structure is collapsed into agency and their properties cannot be examined separately. Both are redefined as “inseparable aspects of a flattened social ontology” (Reed 2005: 296).

What CR seeks to do is to avoid these positions and to take account of a properly argued view of both agency and structure (and culture) and the relationship between them. CR is committed to *analytical dualism* in that structure and agency are seen as objects of a radically different type possessing different properties and powers (Carter and New 2004). For the latter these include self-consciousness, reflexivity, intentionality, cognition and emotionality. The key properties of social structures are anteriority (they are pre-existing features of the world we are born into) and that they are relatively enduring. Among the powers possessed by social structures are those of enablement and constraint.

One consequence of this is that actors are capable of reflection and can formulate

commitments and develop normative projects as a consequence of their deliberations upon their social situation. Contra Bourdieu those in similar social situations may develop diverse subjectivities (Elder Vass 2007). But we do not do this in circumstances of our own choosing. "People choose what they do, but they make their choices from a structurally and culturally determined range of options – which they do not choose" (Carter and New 2004: 3). As seen above structure predates agency. While structure are dependent on activity those actions that produce a given structure may be those of a past generation. Once these differential temporalities of structure and agency are taken into account the close bond between the two, as argued for by central conflationists, is loosened up (Callinicos 2006) and it becomes necessary to differentiate the two and examine their interplay. In order to do so, and to provide concrete methodological form to the analysis of the interplay between structure and agency, Archer (1995) has proposed her morphogenetic model of explanation which works on the basis of a three part cycle of analysis (she proposes a similar approach to the analysis of culture):

- a) *Structural conditioning*: pre-existence structures as generative mechanisms that condition but do not determine;
- b) *Social interaction*: their interplay with other objects including agents possessing causal powers leading to
- c) *Structural elaboration or modification*: non-predictable but explicable outcomes arising from the interactions between the above.

The model allows us to focus on the interplay between structure and agency and the possibility of change arising from social interactions. This arises because agents can formulate projects for change and structures can provide them with the power to carry them through. Thus the transformative potential inherent in human agency can only "begin to bite when structural contexts ...are generally supportive of those potentialities being actualised in some durable form." (Reed 2005: 302). Thus transformation is dependent both on a commitment to change and the capacity to carry it through.

CR and Ethics Education

From the perspective of EE education this approach would seem to have a number of advantages. It avoids the conflationism evidenced in the approaches to EE outlined above. The individualistic approach and that of Bowen are forms of upward conflationism as they focus on the agency of engineers while the analysis of Vaughan suffers from downward conflationism in emphasising the integrating effects of the institutional culture. These approaches are also problematical in that in focusing, on the one hand, on decontextualised individuals and, on the other, the all-encompassing power of institutional logics, they either do not see the need for institutional change or render engineers powerless in bringing about change. Either there is no need for change or no chance of bringing it about.

It can be noted also that while some have called for a greater integration of STS into the study of EE (Johnson and Wetmore 2007) it has been argued that approaches to understanding technology and organisations associated with STS are characterised by a flat ontology associated with central conflationism and pay inadequate attention to the need to distinguish between different levels or forms of analysis in that they tend to focus on the domain of the empirical and the processal character of social reality (Elder Vass 2008, Klein and Kleinman 2002, Reed 1997). These approaches pay inadequate attention to the structural dimension of social interactions with debilitating explanatory and political consequences including the failure of STS scholarship to commit to explicitly normative analysis (see Johnson and Wetmore 2007).

CR encourages us to examine ethical issues in a manner which focus on underlying generative mechanisms and their impacts on engineering practice. For example, in analysing safety and accidents the focus would shift from operator error and the negligence of engineers to the organisational and historical contexts which "generate a pre-accident situation, long before the occurrence of the initiating event and the triggering of the accident

sequence.” (Dien et al. 2004, see Kotta 2011). In this context a key issue is the extent to which dominant views are contestable (Edwards and Wajman 2005) and the manner to which engineers are enabled to contest dominant views. Thus the promotion of an institutional ethics is useful, but does not resolve all issues in that regulation has to be fought for and implemented (Coeckelbergh 2006). Thus we are required to examine the interventions of engineers in the public policy domain and how they contribute to the *structural conditioning* of engineering practice and whether the resulting laws, regulation and practices contribute to *structural elaboration or modification*. By attempting to identify the structural and material preconditions for successful interventions in the world a CR approach can put us in a better position to promote ethical engineering. It also requires us to abandon value neutrality and identify the features of the social structure which need to change in order to facilitate engineering practices which promote safety, sustainability and social justice.

This has important implications for the questions we ask and the methods we use in order to understand educational practices. In effect CR calls us on to redefine the nature of EE and what we should look for in seeking to evaluate the extent to which our students are educated to be socially responsible engineers. The approach outlined above would shift from trying to evaluate the teaching of moral reasoning and a narrow focus on values and attitudes to a concern with the integration in engineering programmes of social and institutional context of engineers work and the role of engineers in promoting policy changes that enable social responsibility. This would require a focus on the use of history, politics and social theory in engineering programmes and the manner in which the broad focus being advocated here could be facilitated. In considering the fuller integration of the social sciences into engineering education a CR approach would shift the focus for educational change from individual educators to academic cultures and organisational processes and force us to ask questions about the “paradox of increasing innovation in engineering curricula coupled with a lack of diffusion of such innovation” (Spalter-Roth and Meiksins 2008). It is only by identifying the structures at work in the domain of the real that we can fully understand what needs to change in engineering education.

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