L. Stapleton & M. Hersh (2003). 'Exploring The Deep Structure of Ethics in Engineering Technology Design and Deployment Methodology', in *Proceedings of the SWIIS International Federation of Automation and Control Workshop/Mini-Conference*, Elsevier: North Holland.

Exploring The Deep Structure of Ethics in Engineering Technology Design and Deployment Methodology

Dr. Larry Stapleton[1] and Dr. Marion Hersh[2]

1. ISOL Research group, Waterford Institute of Technology
2. University of Glasgow

Abstract:

This paper argues that deep structures are embedded in engineering and technology discourse which work against an inclusive and locally relevant engineering ethics. The paper identifies the need for a new, process-oriented, approach to engineering ethics which enables a dynamic, reconfiguration of ethical issues. This approach must be based upon more locally relevant issues and formally recognise the primacy of the other in relation to the self. It proposes the concept of 'gestalt' as the basis for a theory of engineering ethics. In order to operationalise this theory the paper also submits the Johari Window as a useful device for engineering groups wishing to address local, ethical issues.

Keywords: Engineering theory, ethics, social impact, social stability.

1. INTRODUCTION

It is widely understood by engineers and technologists that power relations are extremely important aspects of any theory of social stability, both at a macro or micro level (Stapleton, 2001; Cernetic & Jerman, 1999; Pederson, 1986; Markus, 1984). Any scientific endeavour embodies the structures and ethos of the society in which it is conceived (Kuhn, 1996). Structuralists show how these structures can be extremely endemic and even subconscious, embodied in the cultural artefacts which surround, and perhaps comprise, scientific progress (Foucault, 1965; Dreyfuss & Rabinow, 1983). By extension decision making about technology development is heavily influenced by the typically western ethos of the surrounding society. Other technologies are ignored and devalued. The affects of underlying power structures are manifested in many ways such as native irrigation techniques in Kenya and minority and women's technologies. Another instance is scientific gatekeeping in which only certain types of science and technology are given official sanction and attempts are made to exclude proponents of 'heretical' ideas from access to resources, including publication in respected journals. As a consequence, indigenous knowledge, for instance, of edible plants, is disappearing or even suppressed, since it is not recognised as valid or authoritative (Ilkarracan et al, 1995).

Although it is generally assumed that modern western scientific techniques perform better than traditional methods, evidence shows how traditional methods may be better suited to local conditions. For example, traditional techniques of intercropping have been found to give much better yields throughout Africa than the monocropping techniques suggested by 'expert' agronomists (McCorkle, 1989). Again, centuries old small-scale irrigation techniques used by local peoples perform better than irrigation schemes constructed to fit a 'scientific' model (Ikkaracan et al., 1995).

These examples typify what has been described as a colonialist viewpoint in engineering (Bannerjee, 1999). This view combines a lack of respect for the expertise of indigenous people, minorities and women with a lack of respect for the natural environment and remains a central problem in current approaches to the development of technology. Instead of technology being developed in accordance with local needs and expertise and in harmony with the natural environment, current patterns of technology development have resulted in developmental, social and environmental crises. This gives rises to the question of whose interests this pattern of development serves.

2. RELATIONSHIP BETWEEN SOCIETY, TECHNOLOGY AND SCIENCE

There has been considerable discussion of the relationship between society, technology and science, but power relations have rarely been mentioned explicitly in mainstream advanced technology literature. One perspective considers technology to be neutral in itself and its consequences to be determined solely by the nature of particular applications. An almost diametrically opposed perspective, technological determinism (Ellul, 1954; Winner, 1977), considers technology to be all-powerful. In the strongest versions of this perspective technology totally determines the future directions of society in ways that are not possible to resist. Although useful, both these perspectives are too simplistic. In particular they ignore the power relations and dynamics that effect choices about what technology is developed, how it is used and in whose interests they are deployed. These are highly complex processes that are difficult to address according to the positivism underpinning current engineering research (Jervis, 1997).

Discussion of technology has tended to focus on a particular type of development which has taken place largely in the US, Europe and Japan. An important motivation of this type of technological development has been power, often expressed in financial terms, supported by technological determinism, expressed as the belief that a particular development should go ahead simply because it is possible. Achieving positive social change has generally had little influence on this type of development. Recent technological advances are therefore often considered to be linear, rational, western and gendered. This structure ignores other types of technological development that have occurred at different times and places, and in particular developments by indigenous people and women. It also ignores the hidden structures in engineering which have lead, for example, to a gendering of technology (Grundy, 1996; Cockburn et. al. 1993). These structural affects maintain power relations associated with technology including how engineering organisations function (Wilson (2002)). There are also indications that women and men have different approaches to design (GaBe (1983)).

Privileging certain types of knowledge and social behaviour disables individuals who, for whatever reason, including different cognitive processes, find this type of knowledge difficult to assimilate or this type of behaviour difficult to emulate. Approaches to designing technology can be positioned between two poles: design for norms and design for all. Design for norms is based on the implicit assumption that the world’s population is white and male, whereas the aim of design is technologies, products and processes that can be used by all sections of society, independent of these factors. The two main models of disability parallel this. In model one the medical model focuses on the individual and the perceived loss of in normal functioning resulting from their disability (Swain et al., 2003), leading to a concern with rehabilitation or trying to make the individual confirm to a particular type of society and infrastructures defined for particular norms. Alternatively, the social model, developed by disabled people in the 1970’s and 80’s, emphasises the unequal experiences resulting from physical and social barriers (Barnes, 1994), leading to campaigns to change attitudes and remove barriers and recognition of the importance of diversity in society.

As well as being based on a political and ideological philosophy that advantages an elite minority at the expense of the majority of the population, design for norms is bad design practice. It leads, for instance, to houses in which no-one want to live or Bhopal and other similar accidents (Hersh et al., 2003;). On the other hand design for all can lead to improvements in quality of life and does not privilege any single social group (Bougie, 1991). Related post-structuralist views emphasise different subjectivities, which consider interpretations to be temporary, specific to a particular discourse and open to challenge (Weedon, 1987). As well as allowing interpretations to be located in a particular time, place, political context and ideology, this type of approach could provide tools to challenge the privilege generally given to dominant ideologies or at least recognise the reasons for this privilege.

Technology design and development are influenced by existing power structures and contribute to developing and further institutionalising particular structures (Baudrillard, 1999; Borgman, 1984). Consequently, technology transfer involves not only the transfer of artefacts and associated ‘know-how’, but also the unconscious, or deliberate attempts to impose the economic, political and ideological structures in which this technology developed. This can be considered a form of colonisation through technology, which is subtler, but no less insidious than previous attempts (Banerjee, 2001).

3. POWER RELATIONS, TECHNOLOGY AND ETHICS

Consideration of power relations in the development and deployment of technology raises very important ethical issues. These issues are now receiving some attention (Hersh, 2002; Martin et al, 1996; Barbour, 1992) but the literature in this area remains sparse. Many engineering societies now have codes of ethics or at least codes of professional conduct (Hersh, 1997). However, much technology development theory and practice is still based upon the premise that technology is culturally, politically and socially neutral. Furthermore, it typically ignores the ethical and other responsibilities resulting from the potential power that engineers, and engineering disciplines, have in society.

The consideration of ethical issues frequently focuses on the individual's responsibilities, rather than the development of collective responsibility and organisational and societal cultures of responsibility. While not absolving individuals of ethical responsibilities, a more collective approach, including the development of ethical organisational cultures, would both be more effective and avoid the financial and social penalties paid by individuals who act ethically, for instance by whistle blowing (Hersh, 2001) or refusing to carry out work they consider unethical.

It is apparent that structural affects are subtle, making them difficult for engineers to identify and address. What is needed is a theory of power in engineering that can address these hidden affects at a local level. Also, accompanying practises are required which engineering teams can use to expose these cultural affects in a coherent and open way. This paper introduces the idea of a 'gestalt of power' i.e. a synergistic system of power relations that interact with technology deployment methodologies in deep, but hidden ways. It then proposes a practical technique to address these issues based upon this theoretical approach.

4. GESTALTS OF POWER AND ETHICS

'Gestalt' here refers to a theory of perception developed in opposition to the British 'atomistic' model in which visual patterns were seen to arise from a mosaic of independently existing sensations. The atomistic view represented an attempt to reduce or simplify perceived space into component elements. This is similar to the approach sometimes adopted to engineering ethics. Often, engineering ethics discourse focus on one or two particular issues and attempt to provide a surface level discourse of the issue. For example, Alger, Christensen and Olmsted (1965) represents a traditional approach to ethics in engineering in which ethical issues are addressed as a mosaic of independent issues, such as the ethics of consulting, the ethics of an engineer in industry, government, construction and so on. This approach to ethics details specific sets of surface level issues which western engineers are likely to encounter. It is readily apparent that this is a useful approach as it sets out in some detail guidelines for appropriate professional behaviour.

However, more recently engineers and technologists have attempted to delve deeper, underneath the surface of appropriate behaviours into appropriate attitudes. This is evident in Erman et. al. (1990), the discussion of cultural factors in Martin et. al. (1991) and the discussion of ethical values in Der Vorst (1998). The discussion of these deeper structure issues in engineering has lead to a far richer debate as to what constitutes ethical behaviour. However, to date there remains a theoretical gap in this literature *vis a vis* the organisation of ethical discourse in engineering. At this stage, ethics research needs to find ways in which to organise debate and provide a theoretical framework within which reflective engineers can locate themselves in the grid of complex ethical issues. This needs to be addressed at a personal and inter-personal or, more appropriately, the inter-subjective level.

4.1 Engineering Drawings as a Way of Not Seeing

Debate about technological and engineering ethics often removes the engineer from the context of her invention or his technology. For example, engineering methodologies have built into their very essence this distancing from the locality in which new technology will be implemented. Ihde (1995) argues that the 'visual languages of engineering' (exploded diagrams, drawings etc.) somehow remove the engineer from the context in which the represented objects (technologies etc.) must operate. Therefore, the very approaches used to design and develop new technologies immediately withdraw the engineer from the world in which the new system will be used. It is apparent that the deep structure of engineering visualisations can immediately dis-empower inhabitants of a local context as they disappear from the diagrammatic view. Thus, the ways in which engineers are trained to see (or do not see) the world in which their technologies are deployed has ethical consequences. This also has implications for power-relations in the relationship between engineers and their technologies, and the inhabitants of the social context in which the technologies will be used. This gestalt of power needs to be made explicit and reconfigured in locally appropriate ways. Consequently, devices are needed which can expose the gestalt of ethics and help reconfigure this as appropriate. In this process the gestalt of power will shift through a deeper awareness of my own personal ethical position and its relevance in the local context.

4.2 Towards a Gestalt of Ethics

This paper proposes the theory of gestalt as a means by which we can consider the complex dynamics of engineering ethics. Gestalt, as used by Ihde (1995), implies that the interpretation of an experience changes the experience itself – depictions are interpreted and have meanings, they are not merely objective, engineering diagrams. Gestalt is, therefore, a useful theoretical device for addressing the subjective aspects of ethics i.e. enabling engineering ethics to incorporate a subjective ethics which is culturally-located. By basing itself on a fundamentally post-phenomenological position, this ethics not only emphasises the self (my position in society) it also suggests the other i.e. the need for an inter-subjective approach to ethics. This approach to gestalt emphasises not only what is IN the frame of reference, or what is intentionally perceived (i.e.

what is represented) but also what is outside this frame of reference (Schutz (1973)). Thus we can make a shift from 'ego-centric' ethics i.e. ethical discourse centred on 'the engineer', to a focus upon 'the other' – *their* assumptions, thoughts, fears, concerns etc. This enlarges the vocabulary of engineering ethics without diminishing the individuals response to ethical considerations i.e. it avoids ethical discourse becoming so abstract so as to have little meaning on the ground. Through the post-phenomenological approach, and using the idea of a configuration of issues which are personal and inter-subjective, we can argue that there is a gestalt of ethics which any engineer can discover for themselves, whilst simultaneously recognising that there is much which is not perceived but which is also important. Through gestalt theory and post-phenomenology we can move the debate of engineering ethics towards a debate of 'my' ethics and the 'others' ethics/value/life-world and create new shared spaces between the two.

4.3 Primary Dimensions of the Gestalt

It is apparent that primary dimensions of a gestalt of ethics probably include but may not be limited to:

- Social identity including ethnic origin, religious persuasion, gender, income, disability status and sexual orientation
- social exclusion and decrease of opportunities
- environmental issues
- granularity of responsibility (e.g. individual, group, societal, institutional and disciplinary)
- the distribution of resources and income
- intergenerational issues
- impacts on development
- technological design and deployment issues.
- changes to existing power balances
- restructuring of time: e.g. availability of employment and leisure opportunities
- development and promotion of ethics cultures

It is self-evident that identity factors are central determinants of peoples' expectations and experiences of technology. They also influence available opportunities and the degree of social inclusion, as well as the degree of support encountered in communities of practice. Existing power relations are structurally embedded in identity factors which permit or deny groups and individuals access to technology. These structural factors lead to technology development approaches that can perpetuate existing power relations and inequalities and injustices. These approaches, and their embedded structures, can be challenged by engineers and others as they develop and re-configure their own ethical gestalts and as they actively contribute to the development of an ethical culture in their communities (De Maria, 1992; Hersh, 2002). These cultural shifts provide a basis for the collective action and solidarity, which is a prerequisite for social change. Individual gestalts are essential, both to provide the basis on which the organisational ethical culture can be built and to encompass differences of experience and perspective.

What is now needed are devices by which engineers and technologists can take the primary dimensions of the gestalt and challenge their own gestalts i.e. their own perceptions of ethical realities. The aim of such devices is to highlight both the ethical problems in a particular context and the ethical gestalt of engineers and technologies, rather than to necessarily obtain 'best practice' solutions. In order to provide a practical basis for this work in the engineering community the next section presents a useful and proven technique from educational research.

6. THE JOHARI WINDOW

The Johari window was originally developed as a diagrammatical device by which people may be made more open to one another and is widely used in reflective learning (Brockbank & McGill (1999)). Figure 1 illustrates the typical Johari window.

The quadrants of the window represent one person in relation to others, with each quadrant revealing awareness of behaviour, emotions and subjective space. Some awareness is shared (inter-subjective) and some is not. Material is allocated to a quadrant on the basis of who knows about it. We will now examine each quadrant in turn.

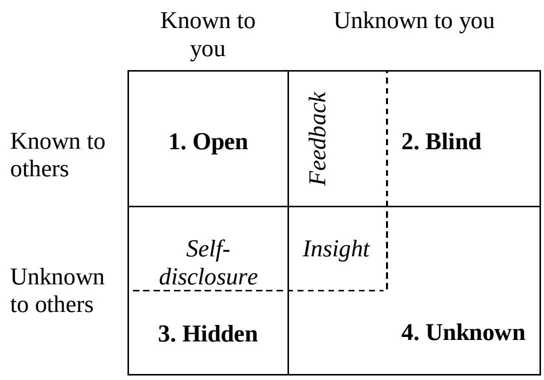

Figure 1. The Johari Window

Quadrant 1: The Open quadrant: behaviour and issues are known to self and others. This is the quadrant that each of us opens to the world and is the basis of most interactions that we willingly display.

Quadrant 2: The Blind quadrant: to that which others see but which I do not. Actions here will be seen in the public gaze – s/he will be aware of some actions (in quadrant 1) and unaware that s/he is displaying other things (quadrant 2). For example, an engineer may not realise that he has inadvertently used a racist expression to another colleague. How the colleague points this out to the engineer and how the engineer reacts will influence how the engineer gets to know about that part of her behaviour of which she was previously unaware.

Quadrant 3: The 'Hidden' quadrant: things I know about myself but which I am unwilling to convey to others. If the engineer discloses issues in this quadrant then they move from here to quadrant 1, reducing the quadrant's 'size'.

Quadrant 4: The Unknown quadrant is something we may get insights into through dreams, psychological counselling and in other ways. This window does contribute to our behaviour but noone, including ourselves, is aware of the deep issues involved.

Now let us review how the Johari window can be used in an engineering work group to raise important ethical issues, maintaining them within their local, intersubjective, context.

6.1 Johari Window in Localised, Ethical Discourse

A group of engineers who wish to explore their own ethical positions can participate in a workshop with an experienced facilitator and use the Johari window to gain potentially deep insights into their own, and others, viewpoints. The workshop will be most effective where major stakeholders and/or a variety of perspectives are brought into the discourse.

The facilitator typically 'breaks the ice' by disclosing something about themselves, thus encouraging others to do the same. It is important that the facilitator ensures that disclosures are appropriate as per Egan (1976) in order to ensure that the ethics, interpersonal psychology and authenticity of the process are protected. The statements that are made need to be authentic as per the following criteria:

- Breadth: how much do you want to tell?
- Depth: level of intimacy
- Duration: amount of time devoted to the process (experience indicates this frequently overruns!)
- Target: to whom is information to be disclosed?
- Relationships: is it a friend, acquaintance etc.
- The situation in which the workshop takes place: for example, private or public place?

There are a variety of guidelines for using this technique and the reader is pointed to Cozby (1973) and Brockbank & McGill (1999) as good sources. However, amongst the most important are: participants should be encouraged to use statements which begin with 'I' rather than 'you', talk about feelings rather than 'facts', avoid the abstract and remain pertinent and interesting. Self-disclosure can be difficult in western cultural settings where self-disclosure is discouraged amongst, for example, students. Reflecting back is also very powerful in this context. It is important to recognise potential power dynamics between different members of the group, due to identity factors, such as gender or race, different experiences and minority positions. This is in addition to power dynamics resulting from different positions in the organisation and the possibility of discussions that should be confidential to the group being reported back to management. As far as possible a 'safe space' should be created for and the expression personal viewpoints or experiences, and practical barriers to doing so, should be recognised. This device can be accompanied by a semi-structured questionnaire exploring primary dimensions of the gestalt which the group wishes to address (Stapleton (2002)).

The essence of the approach is to expand quadrant 1 in terms of personal ethics through an increased awareness of the engineers' personal values as well as an impression of others' personal positions and ways in which personal ethics impinge upon others.

7. CONCLUSION

It is readily apparent that technology and engineering are not immune from the power relations that impinge upon global society. This raises deep questions about the nature of engineering, what it can achieve, and, indeed, what it can mean to those outside the discipline. The paper recognises a need for theories and techniques that can be co-opted from other disciplines into engineering education and practice. These theories and techniques must recognise that all power is localised and impinge upon individuals. They must also recognise that ethical considerations must be understood in their inter-subjective, localised context. The paper briefly outlines a theory of ethics that is informed by post-phenomenological views of gestalt – the dynamic, re-configurable perceptual framework within which humans perceive (or do not perceive) the world. This theory argues for an ethics based upon context – i.e. both the individual 'I' and the 'other' with whom I live in the world and whom I impact through my engineering. It then proposes one practical approach, the Johari window, as a means for igniting healthy debate by exposing the deep structures underpinning individual ethical positions within the engineering community. This approach makes more explicit individual and group gestalts and recognises the ability for participants to reconfigure this gestalt through their awareness of others.

This approach begins to account for power issues in their relation to engineering ethics. Further work is required to account for when 'I' am the 'other' i.e. for engineers who experience social exclusion either for identity reasons such as being female or black or due to (design) approaches which are not part of the engineering mainstream. This is an ethical research imperative.

REFERENCES

Banerjee, R. (2001). Biodiversity, Biotechnology & Intellectual Property Rights: Unpacking the Violence of 'Sustainable Development', *19th Standing Conference of Organisational Symbolism*, Dublin.

Barbour, I. (1992), *Ethics in an Age of Technology*, The Gifford Lectures Vol. 2, SCM Press.

Baudrillard, J. (1999). *The Consumer Society: Myths and Structure,* Sage: Thousand Oaks.

Borgman, A. (1984). Technology and the Character of Contemporary Life: a Philosophical Inquiry, University of Chicago Press.

Bougie, (1991). The impact of new technologies on the quality of life of persons with disabilities, http://press/coe.int.cp/2001/in361(2001).htm

Cernetic, J. & Jerman, S. (1999). A Soft Change-Management Approach Applied to Information Systems Development, in *Evolution and Challenge in Systems Development*, Zupancic, J., Wojtkowski, W., Wojtkowski, W.G., Wrycza, S., (eds.), Kluwer Academic/Plenum Publishers: NY, pp. 719-726.

Cockburn, C. and S. Ormrod (1993). *Gender and Technology in the Making*, Sage: CA.

De Maria, W. (1992). Queensland whistleblowing, *Australian J. of Social Issues*, **31(1)**, 248-261.

Dreyfuss, H. & Rabinow, P. (1983). *Michel Foucault: Beyond Structuralism and Hermeneutics*, University of Chicago Press: Chicago.

Ellul, J. (1954). *La Technique ou l'Enjeu du Siècle*, Librairie Armand Colin, Paris.

Ezrahi, Y. (1995). Technology and the Illsuion of the Escape from Politics, in Ezrahi,, Mendelsohn & Segal (eds.), Technology, Pessimism and Post-Modernism, Univ. of Massachusetts, MA. pp. 29-38.

Grundy, F. (1996). *Women and Computers*, Intellect.

Hersh, M.A. (1997). Environmental ethics for engineers, *Engineering Science and Education Journal*, **9(1)**, 13-19.

Hersh, M.A. (2002). Ethical Analysis Of Automation: A Comparison Of Different Ethical Theories Through Case Studies, *SWIIS '02, Vienna.*

Hersh, M.A. (2002). Whistleblowers – heroes or traitors? Individual and collective responsibility for ethical behaviour, *Annual Reviews in Control*, 26.

Hersh, M.A. and I. Hamburg (2003). *Mathematical Models for Sustainable Development*, Springer Verlag, in press.

Ihde, D. (1998) *Expanding Hermeneutics* Northwestern University Press: Ill.

Ilkkaracan, I. and H. Appleton (1995). *Women's Roles in Technical Innovation*, Intermediate Technology Publication.

Foucault, M. (1965). Madness and Civilisation: A History of Insanity in an Age of Reason, Vintage Books: New York.

Jervis, R. (1997). System Effects: Complexity in Political and Social Life, Princeton Univ. Press: NJ.

Kuhn, T. (1996). *The Structure of Scientific Revolutions*, 3rd Ed., Univ. of Chicago: Mich.

Latour, B. (1999). Pandora's Hope: Essays on the Reality of Science Studies, Harvard: MA.

McCorkle, C. (1989). Price, preference and practice: farmers' grain disposal decisions in a Burkibane community. In *The Dynamics of Grain Marketing in Burinka Faso*, vol. ii, University of Michigan Centre of Research on Economic Development.

Markus, L. (1984). Systems in Organisations: Bugs & Features, Pitman.

Martin, M.W. and R. Schinzinger (1996). *Ethics in Engineering*, edition, McGraw Hill.

Pederson, P. (1986). 'Organisational Power Systems', in Bjorn-Anderson, N., Eason, K. & Robey, D., *Managing Computer Impact: An International Study of Management and Organisations,* Ablex: NJ, pp.127-149.

Stapleton, L. (2001). 'Information Systems Development: An Empirical Study of Irish Manufacturing Companies', Ph. D. Thesis, Department of Business Information Systems, University College, Cork, Republic of Ireland.

Stapleton, L. (2002). Supporting Organisations Learning from Information systems Development: A Research Imperative, International. Symposium On Research Method, RTU, Latvia.

Stapleton, L. (2003). 'Information Systems Development As Folding Together Humans & IT: Towards a revised theory of Information Technology development & deployment in complex social contexts', in Grundspenkis, et. al.(eds.), Information Systems Development: Advances in Methodologies, Components and Management, Kluwer: forthcoming.

Weedon, C. (1997). Feminist Practice and Poststructuralist Theory, Blackwell, Oxford.

Wilson, E. (2002). Family Man or Conqueror? Contested Meanings in an Engineering Company', *Culture and Organisation*, pp. 81-100.

Winner L. (1977). Autonomous Technology¸ Technics-out-of-Control as a Theme in Political Thought, MIT.