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Engineering as Philosophical Ethics

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This article is a call to action. The responsibility of engineers in the globalised economy of today goes well beyond the technical and empirical. Engineers must face the value issues that conflict policy makers and offer positive recommendations that are developed as an essential part of the engineering process itself. At present, this is not possible because engineering labours under the false presupposition that its choices are technical and otherwise value neutral. Engineering needs to expand its own discourse to make value deliberations interior to it. This is different than professional ethics and most closely resembles philosophy.

INTRODUCTION

In previous presentations to the UNESCO International Centre for Engineering Education (UICEE), the author has argued that engineering and perforce engineering education have now become global phenomena. This fairly recent circumstance requires a modification of engineering practice to accommodate cultural, economic and political differences that become increasingly evident as technology *flattens* the world.

The author has also tried to make the case that the best way for engineering education to prepare competent and responsible global practitioners is to infuse technical training with the study of natural science, mathematics and the liberal arts, especially language, literature, history and philosophy. These disciplines, when properly coordinated with knowledge of modern technology, can prepare engineers to make reasonable and responsible decisions regarding the deployment and utilisation of the vast new powers unleashed almost daily by technological advances.

Although this recommendation may sound obvious and non-controversial, the process of implementation is daunting and engineering faculties often resist any proposal to revise curriculum that might dilute the content of the core disciplines. The recommendation leads to at least two fundamental questions that must be addressed as one contemplates the reformation of engineering education.

- How can new pedagogical materials be incorporated into the already overcrowded and demanding engineering curriculum?
- Why is globalisation important and how can the new world realities be incorporated into engineering education?

Before turning directly to these questions, we need to consider the special character and importance to societies of engineering itself. This point has particular educational relevance, as it is sadly the case that students who plan to enter engineering as a profession rarely have reflected on this aspect.

Engineers have a special responsibility that attends their role as designers and fabricators to ensure the safety, reliability and sustainability of the world where we all live. This responsibility is fundamentally ethical. It is an imperative that all humanity shares, but which engineers and technological innovators must define. This imperative may be called *engineering ethics* and it demands the urgent attention of the best and brightest in the global technological community.

Engineering ethics is distinct from technological ethics because of engineering's immediate involvement in world-modifying action. Technology always presents the question, as does science, of whether its special

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knowledge should be put to use and, if so, how and to what extent. Engineering *is* the application of technology. The question has already been answered. Engineering may solve or create problems, or it may make more or less neutral changes, but the contemplative moment of restraint has been passed and, to some extent, the world will be different physically as a result. In some cases, the difference will go unnoticed or perhaps be reversed. However, in most cases, engineering activity makes permanent – if not irreversible – changes in the material world.

RESPONSIBILITY

Engineers, of course, have a profound responsibility to understand the science and technology they put to use. Bad and potentially destructive engineering can result from misunderstood science. Yet engineers have a challenge greater even than the precise and wise use of science. This is the case simply because the overwhelming majority of life and death decisions follow from problems that are the consequence of technology, require technology to solve them or, highly likely, both. Clearly engineers are found in the midst of such quandaries.

Engineers have often been asked to manage problems caused and pursued by others. The role of the engineer in the military is a prime example of this situation. Political conflicts and the military means to resolve them create classic engineering challenges: transportation, sanitation and communications. There is no debate that such challenges must be met and that the quality of the solutions is vital. But quality is a very broad term that encompasses a range of human options that involve issues of fairness, justice, happiness and a myriad of other fundamental values. Engineering solutions are *human solutions*, the material embodiment of human choice and human preference. As far as we know, machines do not care! For this reason, the engineer represents all of humanity, as well as setting the agenda of possibilities for all peoples, now and in the future.

If human purpose and value are to be respected, then engineering must concern itself with the principles of ethics as much as with the principles of science, mathematics and material nature. Engineering is as much a part of the humanities and social sciences as it is the hard sciences or technology.

Therefore, let us assert that engineering is *concrete* ethics. It is concrete because the expression of its ethical reflection is in the form of artefacts, devices and structures rather than abstract theory. How do engineers do ethics?

The author thinks that, as ethicists, engineers have generally been partisans. They have not thought their job to be to articulate what is best – good, beautiful and true – for all humanity. They have not, like Kant, posited categorical imperatives. Rather, engineers have seen it as their task to solve local problems, ameliorate specific difficulties, develop more efficient processes, and advance the economic well-being of particular interests. Engineers compete and believe that competition fosters innovation and superior solutions. In a sense, they have been like those religious ethicists who proclaim the standards for their own faith community, believing them to be superior to those of others.

Such partisan or parochial approaches do not serve communities with diverse interests, traditions, social mores and cultural practices. These approaches do not serve global communities. It is possibly the case that globalisation has contributed to the rise of sectarian-inspired conflict. In the realm of technology, where the global distribution of resources is uneven and where outsourcing is rampant, sectarianism should not be granted a foothold. What this implies is that engineering ethics cannot continue only as a kind of watchdog vigilantly overseeing the standards of each project. Nor can it assume that ethical standards already exist that are appropriate for the novelties technology produces. Rather, engineering ethics is going to have to embrace the classical questions and propose answers informed by comprehensive and adequate understanding of our new technological powers.

THE ENDURING, CLASSICAL QUESTIONS

What are these classical questions? Philosophers over the centuries have struggled to identify the qualities of the good life, to understand the basis of duty, and to calculate individual and social benefits. Many discussions of ethics are embedded in religious, cultural, political, economic and scientific discourses. For the most part, engineering has formulated its problems without reference to these value-laden discourses. But the more engineering becomes *the* mode of human action to resolve human problems, the less it can avoid these value references. The classical questions need to be reformulated in light of contemporary and future global and technological realities.

It should be obvious that engineering or some closely allied discipline will become the basis of much human interaction, mediating human exchange on multiple levels. Whether one considers the intimate relations within a family or the disputatious choices made in the public realm, the opportunities for action are difficult to imagine devoid of some kind of technical mediation. The choices one makes on behalf of an

aging family member or decisions to be taken regarding urban mass transportation or the allocation of resources for future consumption, these and innumerable others, are all vital to human well-being *and* dependent upon the state of available technology. In short, the work of an engineer stands amid every human exchange.

IMPLICATIONS FOR ENGINEERING EDUCATION

Thus, with respect to our first question regarding engineering pedagogy, the realisation of the profound ethical dimensions of engineering practice suggests the need for a fundamental reorientation of engineering education. If this is the case, then it should be clear that the first step would not be a proposal to the university curriculum committee. Proposals should rather be directed to university research committees because what is at stake is the basis of engineering methodology.

Perhaps engineering will become the globe's primary practical discourse. However, for anything like that to happen, engineering must eschew its uncritical approval of free market capitalism at the same time that it integrates deliberation on value questions (without sectarian influences) into its general approach. In turn, this cannot happen without extensive reflection and discussion, and at least tacit commitment to the importance of the endeavour from key elements in the global engineering community.

Engineering is not a *value-free* discipline. It has sometimes been casually assumed that since engineering is applied science, carrying out the mandates of natural science research, which is, of course, value independent, that such independence descends to engineering activity. This is wrong on several counts. It is naïve to think that science *research* is value free, even if the pure search for scientific truth ultimately is. Also, to construe engineering merely as applied science abstracts from much of what is importantly engineering. And, obviously, to think that engineering, which is our most systematic effort to solve human problems, is not precisely an expression of value is absurd.

The misunderstanding resides in knowing exactly what this systematic effort should be. Engineers like to see their profession as non-political, rational and guided by fact. Engineering needs to undertake an examination of itself, a meta-inquiry aimed at disclosing its epistemic status and its unstated but commonly held presuppositions. If it is indeed the case, as the author maintains, that as a matter of professionalism engineering denies its political agenda, then it is in danger of becoming the compliant handmaiden to any political end, however invidious. Some among us would probably assert that German engineering demonstrated this under Nazi rule. However tragic this example is, it may not be the most trenchant. Certainly, resistance to a pernicious and hateful ideology such as Nazism is something we should expect simply as a matter of human decency; if a profession requires more guidance, then the failure lies with civilisation itself. However often and, the author believes generally, circumstances do not provide such morally clear options. This is true *a fortiori* when technology is determinative. Before turning directly to this, let us pick up one additional strand.

THE MORALITY OF ECONOMIC DEVELOPMENT

A recent book by the Harvard economist, Benjamin M. Friedman, argues, on the basis of historically demonstrated econometrics, that economic growth is the necessary (but not sufficient) condition for the decent or moral society [1]. A similar point has been advanced by Amartya Sen based upon his study of famine and starvation; numerous other works by Sen also advance this thesis [2]. Both of these distinguished economists insist that rational economic development tends to undermine political tendencies towards discrimination and injustice. In his advocacy of globalisation (it should be noted an *American-style* globalisation), Thomas Friedman claims that free markets advance the welfare of all those that participate in them [3][4]. The argument, at least in liberal circles, is that rational economics shows how to expand the availability of goods and services and this expansion is an objective measure positively correlated with the quality of life.

In a sense, it is this argument that legitimates engineering education within universities. C.P. Snow's *Two Cultures* still characterises the dominant intellectual outlook in Europe and the USA, although Chinese and Indian universities assert a globally powerful alternative view [5]. Indeed, his view suggests a dereliction of responsibility on the part of humanists. In the West, the introduction of technical studies into the university was a slow and contentious process, enabled more by economic circumstances and political decisions than an embrace within the educational community. The justification of engineering within the universities – a point perhaps not fully understood or appreciated by engineers – is based upon altruism. Engineers build up communities in order to strengthen their economic and social well-being. Engineers are employed in the service of the economic and social planners who, in turn, are informed, not by

technology, but by history, philosophy and tradition. The argument on the level of engineering education is about how much, if any, knowledge of these liberal arts subjects do engineers require in order to fulfil their social mission. Generally speaking, the answer has been *not much*. Communications skills and professional ethics are central to most engineering curricula, but are presented only for their utility and not to foster a contemplative or critical mindset.

This problem is compounded by the prevailing assessment in the 20th Century of technology made by leading Western philosophers, theologians and humanists. For example, the influential thinkers Martin Heidegger and Jaques Ellul both argued that technology was a pernicious and nearly totally determining influence on the quality of human existence [6][7]. According to them, there are highly problematic, undesirable and inevitable social, political and economic consequences of technology. They do not see technology in the service of the good life but anticipate a future where we are doomed to lives that are organised and priorities set by the demands of machines and systems. Another *two culture* divide separates those who optimistically embrace technology and those who fundamentally deride it.

There are two points here. First is that the training of engineers does not prepare the technically and scientifically competent, discursive, public intellectuals who are needed in the world driven almost entirely by technology. The second is that because engineers tend to be uncritically accepting of the stated virtues of free market capitalism, they are unwitting collaborators in a system that may not advance the social goods that they prefer.

THE ESSENTIAL GLOBALISATION OF ENGINEERING EDUCATION

Why is this specifically a global problem? Or, perhaps more trenchantly, *Why must engineering education absorb the impact of the shifting economics of today's globalisation?* Is it not enough for engineers to apply their professional concern to issues of quality, safety, durability, efficiency, and the other traditional standards? Why is any of this different in a global context?

As a historical question, Jared Diamond addresses this lucidly in such books as *Guns, Germs and Steel*, where he describes the factors that explain the unequal development in various parts of the world [8]. The differences are all due to the consequences of technology, at least if we include agriculture and medicine among technologies. His point is rather straightforward: global exchange (trade, communications, etc) for the sake of economic development does not ensure equitable technology transfer. Indeed, as is manifest today, economic globalisation is largely a process of seeking out cheap labour and *not* one of transferring technology. The case of China makes the point; Western industry has moved manufacturing to China because production costs are considerably lower there than in Europe or the USA, but has tried, not entirely successfully, to prevent the engineering and management expertise from taking root.

The following points comprise this issue:

1. The economics of globalisation encourages the outsourcing of manufacturing to gain price point advantage;
2. This advantage is lost if technical and management expertise is transferred along with the manufacturing;
3. Engineers, the experts that add value to new products, do what they are asked where they are asked.

Clearly, point three is not one only of economic success but emphatically one of human value. Indeed, economic success is nothing other than human success and the very idea of human success transcends the categories of material wealth. It should also be noted that Diamond's books all tend to demonstrate how technological choices have determined the path of history.

In *Guns, Germs and Steel*, Diamond addresses what he calls *Yali's question* as follows:

> *In a conversation with a local politician named Yali in New Guinea (before independence) Diamond, who was there to study bird evolution, was asked this question:* Why is it that you white people developed so much cargo and brought it to New Guinea, but we black people had little cargo of our own?

By cargo was meant manufactured goods and the complex economic arrangements needed to deal with them. The answer that the West developed long before New Guinea only begs the question. What are the differences that make a difference and why? Why do some societies develop specialised industries, commercial practices, a myriad of goods and services unique to themselves, whereas other societies follow entirely different developmental paths? And how do we reconcile these differences when societies interact? This book was published in 1990 and the conversation was reported as having taken place some 28 years earlier. However, the question persists.

The case being made is that versions of Yali's question need to be taken up by engineers – not simply as a matter of concerned citizenship, but as an element central to engineering activity itself.

Engineering needs to embrace ethics as part of engineering itself, ie engineering ethics should find its source within engineering itself and not accept ethical standards legislated from without. By *engineering* ethics is meant something other than professional ethics. Professional ethics, as promulgated by the professional engineering societies, consist basically of deportment protocols to ensure the integrity of contract work. Such ethics are vital to professions and certainly should not be abandoned and perhaps need strengthening in light of technological advancements. But this level of ethical discourse accepts the overall legitimacy of engineering projects; it does not raise the question of whether a new highway or light rail is the better alternative or whether any new infrastructure is even appropriate *from the standpoint of the social good.* Of course, engineering firms make recommendations regarding preferred engineering solutions in the narrow sense. What is needed is the broadening of that sense to include systematic considerations of the common good from all perspectives. What are these perspectives?

A definitive list is not possible as the dynamics of any social-political reality pose far too many variables. However, here are some of the obvious perspectives, in no particular order, that need to become a normative part of engineering planning, as follows:

- Environmental;
- Economic;
- Health;
- Safety;
- Cultural;
- Educational;
- Resource allocation;
- Sentimental;
- Religious;
- Aesthetic.

Most people will assert either that the above concerns are *not* engineering concerns or that engineers already consider them in an appropriate fashion. Let us evaluate the latter assertion.

This assertion rests upon the flawed assumption that engineering is either value free or that its values are socially neutral. But clearly this cannot be the case when one realises that engineering activity is the primary mode by which humans deal with the physical, material world. Engineers are *world makers* who alter nature, create and destroy, establish life-patterns, create choices and eliminate others, determine what we eat, how we sleep, to what extent we are secure, what responsibilities are ours individually and/or collectively, and so on and so on. In a word, engineers make life what it is and, therefore, *as* engineers have a strong duty to understand and communicate the forces they deploy.

Of course, this does not imply that engineers alone should run the world. Rather the startling notion that engineers make life and nature what it is today must introduce a profound sense of humility into any deliberations concerning the deployment of new technology.

ENGINEERS WHO ARE PHILOSOPHICAL KINGS?

It is noted that, while Plato's famous philosopher king in *The Republic* was, in our terms, the CEO of an engineering firm (called the guardian class) and was hired to manage every detail of human life, the one big lesson of that book was that such a utopian technocracy will not succeed in creating justice or human happiness [9]. This is the case even when the technologies themselves can be controlled and their objectives achieved with predictability. Alan Bloom's *Interpretive Essay*, included in his translation of Plato's *Republic***,** expounds on this.

The reference to Plato helps us understand the shortcoming of technocratic society. The world does not need an engineering king, but rather groups of engineers who resemble Aristotle's *phronemos* – leaders who exhibit practical wisdom. Karl Popper's philosophical critique of the decline of European politics in *The Open Society and its Enemies* proposes (piecemeal) engineering as the model of political discourse as an alternative to Platonism because he believes it respects human choice and freedom [10].

However, what Popper intends by engineering is not a dogmatic technocracy, but rather a deliberative community that is perpetually revising itself as matters become clarified. This is all the more an important requirement now in the context of the globalised economy. In this classic, Popper interprets Plato as the intellectual precursor of totalitarian systems. In his well-known and much appreciated book, *The Logic of Scientific Discovery*, Popper also argues for the centrality of humanistic learning in the evolution of scientific understanding [11].

The empirical methods and iterative processes of engineering need to be applied to the fundamental questions of human science, ie the problems facing humanity. This task is one for universities to lead. The author's University, Polytechnic University in New York, USA,

for example, has recently signed Memoranda of Understanding with Asian technological universities to collaborate on education and research projects – all of them with consideration of their ethical, social, political and cultural implications and consequences. It is our hope that this incorporation of humanistic inquiry within engineering research will advance our understanding of the relation of technology to human value.

CONCLUSION

The reorientation of engineering education in the direction that acknowledges the centrality of the ethical imperative is one that will not come about through the normal process of curriculum reform. Similarly, the challenges of globalisation cannot be addressed adequately by the introduction of new courses that are designed to develop international competences. What is called for is the recognition on the part both of practicing engineers and engineering educators that most aspects of engineering work are far from value free but, on the contrary, are dedicated to a proposition of human interest. How human interest as a metric of engineering quality is to be incorporated is perhaps the most important question to be faced in the assessment of engineering methods and methodology. An understanding of this will emerge only from an extensive discussion among engineers and engineering educators from around the world.

In his book on anthropology, Kant gives the image of guests invited to a luncheon where good food and good conversation are the norm [12]. The good conversation develops because the guests with their many differing opinions are all respectfully given the chance to speak their mind. As a result of this exchange of opinion, what emerges is an improved and enlightened understanding on the part of all in attendance. This is the process, although it may be convened over the Internet rather than around the luncheon table, that engineers today must undertake. We need, as engineering educators, to take the lead, to begin the conversation and to expand the legitimate discourse of engineering in order to produce more enlightened understanding about the way that technology forms the world.

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BIOGRAPHY

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In July, 2006, he was awarded the UICEE Silver Badge of Honour for *…distinguished contributions to engineering education, outstanding achievements in the globalisation of engineering education through the activities of the Centre, and, in particular, for remarkable service to the UICEE.* He is completing a book titled *From Tradition to Technology: the Ontological Ethics of Hans Jonas*.