

## "How can we have ethical and sustainable engineering in a world dominated by market forces?"

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***Abstract:** In this paper we reflect on the world dominated by market forces; that globalisation is working for the few, not for the many; that international trade is becoming increasingly knowledge intensive; that globalisation is exploitative and oppressive; and that engineers need to work in this environment. Engineers cannot divorce themselves from this context as their work is intimately enmeshed with the stakeholders of the global marketplace.*

*The paper calls for the engineering education curriculum to focus on the ethics of engineering practice as a matter of urgency. We need a shared ethics of engineering practice grounded in an understanding of the rights and responsibilities of engineering in a global context, and commitment to make engineering work for the poor.*

*Engineering and engineers must learn to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality by way of participative democratic processes. Working with the polity must become the norm in engineering practice. Engineering education must make this paradigmatic shift in order to become ethical and sustainable in the global context.*

***Keywords:** globalisation, sustainability, knowledge-intensive, oppression, participative democracy*

### Introduction

*“The **self-organizing principles of markets** that have emerged over the past 10,000 years are in conflict with the **self-organizing principles of ecosystems** that have evolved over the past 3.5 billion years.” Adbusters (2003)*

Rapid global developments over the past two decades are impacting on engineering as a philosophy of practice in significant ways. While the practice of engineering has been responsible for many of the technological advances that have contributed to global change, this change has been so dramatic, so rapid and so significant that ethical and sustainable engineering practice is struggling to keep pace.

As engineering educators, we are exhorted to make our curricula global in outlook to keep pace with the changing face of industry, but never to question the ethical implications of these changes and the way they shape our world. A global outlook in engineering education tends to be little more than an understanding that jobs for our graduates are likely to be offshore; that our students need to be able to function in culturally different environments; and that the nature of their work will undergo vast change in their lifetime. There is a lack of attention to and understanding of the impact of globalisation on our societies, on our industries and on the increasingly questionable ethics of the interactions our graduates are likely to have in the global marketplace, particularly in the developing world.

### **A World Dominated by Market Forces**

From an engineering perspective, technological advance strongly correlates with engineering problem solving for societal improvement. Taken in isolation, this is a very worthy objective. However, when coupled with a working environment dominated by market forces, this objective is rapidly subsumed by the all-consuming need to post profits for shareholders. A recent report by OXFAM (2002) on trade, globalisation and poverty argues that globalisation works for the few, not for the many; and that globalisation of trade, which fuels technological advance, currently leads to extremes of prosperity and extremes of poverty. Global markets operate on the basis of fewer and fewer shared values- the 'bottom line' has become the dominant one -to the extent that markets now dictate politics and political decision making. Values relating to ethical or sustainable practice or advancement for the social good have all but disappeared in this new climate. Companies of the industrialized world aggressively enter into arrangements that are most profitable for their own interests, but ultimately damaging to the interests of their trade partners in the developing world, creating a kind of 'dictatorship of wealth'. The interdependence of the global economy means that all countries are now more closely linked than ever before and increasingly depend on each other for prosperity, but this dependence does not automatically lead to societal improvements.

The OXFAM report argues that international trade is becoming an increasingly knowledge intensive activity and that trade of high-tech goods is rising fastest of all. Technologies requiring heavy investments in R & D and sophisticated technology infrastructure are now the most dynamic growth areas of international trade. At the same time, advances in computing and telecommunications have brought unprecedented opportunities for the expansion of trade, and the new technologies are creating an ever-denser network of connections between the developed and the developing world. This is one of the defining features of contemporary globalization.

However while new technologies have made globalisation possible, and the transnational corporations make it happen by creating a global marketplace and providing the impetus that drives increased interdependence, the idea that world trade is about countries exchanging goods with each other is an anachronism. Trade, because of the gate-keeping role of the transnational corporations in markets, investment and technology, has become an 'inter-corporate' affair. Access to technology is a requirement for successful entry to the global marketplace, but technology transfer is no longer a simple exchange. In fact it doesn't happen. It is dominated by patents owned by the transnational corporations, and control over technology and the profits that technology offers in a knowledge-based economy are at the heart of disputes about Intellectual Property at the World Trade Organisation (WTO).

Technology is being used to replace labour – in food production (intensive agriculture), in manufacturing (use of machines and robots) and now in knowledge-intense industries (call centers). If selling labour is still the primary engine to make the blood of the market flow – where will this labour be required? It will really only be required in developing nations at exploitative rates of pay and Dickensian working conditions until better ways of production are found.

For very many countries in the developing world, the effects of globalisation have not always been benign. Instead of increasing the knowledge-based wealth of developing countries, technological advances and the control of the global marketplaces by these vast corporations have seen the movement of Research & Development (R&D) out of developing countries. The corporations bring their own R & D into foreign companies, effectively closing down local R & D, which cannot compete either on scale or in terms of investment. In other cases globalisation is producing poverty-level wages, severe forms of exploitation and environmental degradation. Mineral deposits are often located in ecologically fragile areas and on the lands of marginalised groups such as indigenous communities who lack the political power to resist the commercial imperatives of large corporations, resulting, as in the case of copper mining in Indonesia, in severe damage to the environment and an abuse of human rights. Africa contains about one-third of the world's total mineral reserves and is a major producer of oil, gas, diamonds and uranium through the interests of transnational corporations, yet has the most people living in poverty on earth. Malaysian women working in the plating section of electronics factories, servicing the needs of transnational corporations, report health problems ranging from miscarriages to respiratory difficulties. The injuries, risks and long-term damage suffered by unprotected workers represent a labour cost that is not reflected in export prices. (OXFAM, 2002)

The role of engineering in these contexts is also being reduced to a commodity in the market place. Advances in technology made possible by engineering ingenuity, have been hijacked by the rule of markets for the sole purposes of increased profit regardless of ethical and sustainable practice. Take the case of access to water, which is now said to be the new 'oil' of the 21st century. Water is at the heart of life, yet many millions of people around the world do not have access to it, and the current sources and cleanliness are increasingly under threat by unsustainable agricultural practices and global warming. Access to water is becoming the cause of tensions and even war between nations. Many would agree that water should be delivered as a fundamental human right for every person on earth, and that the role of engineers is to develop the technical means of achieving this. However, multinational companies are moving into the water “market” in the developing world, privatising access to this fundamental commodity.

A recent report by the ABC's 'Background Briefing' revealed that 250 million people around the world now pay for water from private companies. When taps are turned on in Adelaide, cash registers ring in London, Paris and Houston. While many would argue that water should not be owned by anyone, the global trends are showing increasing privatisation, and the recent Third World Water Forum in Kyoto highlighted many of the problems associated with this for the developing world. In Kochabamba, Bolivia, the World Bank encouraged a private water company owned by a US transnational corporation to 'solve the problem' of long term water shortages in that area. The result was a 300% increase in the price of water. The people of Kochabamba organised a blockade and 8 days of protest. Martial law was declared and many were injured and killed. This popular pressure eventually forced the government to break the contract with the transnational corporation and return water to

collective ownership. The transnational company is now suing the government of Bolivia for \$30 million for loss of earnings.

The formal report arising from this World Water Forum run by the World Water Council and multinational corporations aroused massive protest from peoples of the developing world. Private international water companies were strongly represented in the report and the World Bank is closely aligned with the World Water Council, arguing that the only way to tackle the global water issue is to allow private companies to get into poor countries to privatise water. The WWF report ignores the many examples of privatisation that have done nothing but exacerbate the differences between rich and poor. Water privatisation in Manilla resulted in water rates rising by 500% with more rises on the way as the multinational operating the company is operating at a loss and threatens to walk out unless the price of water is raised even more. The cost of this on an average Manillian is 1000 pesos a month for water alone, when they only earn 3000 pesos a month. Globalisation of water is also breaching the rights of indigenous people. Traditional wells are drying up because multinational companies like Coca Cola are extracting massive amounts of water from local aquifers, lowering the water table and reducing access to traditional wells.

While the World Bank needs to be asking who can deliver efficient water services and quality water to the poor at the lowest cost, the current practice is that funding packages from the World Bank are given to the private sector exclusively even though the water issue is not a 'viable' business proposition to companies who can only make profits through improved efficiencies and profits don't come from connecting the world's poorest to the system. SUEZ is the biggest water company in the world with \$8 billion turnover a year. At the Kyoto summit, SUEZ was spelling out the problems of trying to make a profit solving the developing world's water problems and put forward strong arguments that the public should carry the risk for the private sector, providing these companies with guarantees against currency fluctuations and other risks. Currency devaluations have impacted adversely on their investments and these multinationals want a 'rebalancing' of these risks between the private and public sectors. They are asking, in effect, for the World Bank to underwrite the risk, providing a subsidy in the order of hundreds of millions of dollars to these private companies, all cloaked in the language of helping the poor. There needs to be more realism about what the private sector can and can't deliver to the world's poor, and our engineers need to be a strong voice in this debate.

There is growing realisation that privatisation is not the answer to world water access and sewage problems, and that multinationals won't be the salvation of the poor. "The truth is that big water projects of the kind the private sector is good at building and operating – with their large reservoirs, pipelines, aqueducts and pumping stations – are largely irrelevant to the needs of the poor. Worse, such projects often end up stealing their water, giving it to cities and commercial farmers." (New Scientist, 1996: 38) There is a clear need for strengthened public utilities and for supporting Non Government Organisations (NGOs) in the developing world to look for solutions for getting clean water to the poor. The same *New Scientist* article reports on the case of the citizens of Orangi, a shantytown in Karachi who "were for decades promised new sewers by the city authorities. Nothing happened so they collected subscriptions and organized a sewer system". This is a case of the public sector supporting local funding to bring sewage systems to large numbers of poor people. They, like Friere (1996), saw that local problems needed to be solved locally and that engineering solutions can be found for local problems. Their schemes have cost 25% of what it would have cost with international money and involvement.

## **A Call for Ethical Engineering Practice**

This is the new environment our graduates will have to work in. No longer will their expertise be confined to their technological knowledge, but they will be required to operate in a fiercely competitive market driven world, developing products and processes that can and are being used to exploit and oppress humanity in the developing world.

The need for ethical engineering practice has never been so urgent. The world has yet to develop institutions and systems of co-operation capable of responding to the problems created by globalisation. Clearly there is a need for a model of inclusive globalisation based on shared values and principles of social justice rather than the immorality of a system ruled by market and commercial values alone. Engineers cannot divorce themselves from this context. Their work is intimately enmeshed with the stakeholders of the global marketplace.

We need a shared ethics of engineering practice grounded in an understanding of the rights and responsibilities of engineering in a global context, and a commitment to make engineering work for the poor. As a group, ethical engineers should take the courage to focus efforts on the critical issues for the 21<sup>st</sup> Century, not let our effort be frittered away on what the market wants or what may bring us the most money. This effort should be focused on doing *with* the poor not doing *to* the poor.

### **The Oppression of the Poor**

Richard Schull in the Foreword to Paulo Freire's (1996) revolutionary work reflects on

*“the culture of silence” of the dispossessed.... that their ignorance and their lethargy were the direct product of the whole situation of economic, social and political domination – and of paternalism – of which they were victims. Rather than being encouraged and equipped to know and respond to the concrete realities of their world, they were kept “submerged” in a situation in which such critical awareness and response were practically impossible. And it became clear ... that the whole education system was one of the major instruments for the maintenance of this culture of silence.”*

This “submerging” of people in the situation is relevant in two significant ways in this paper – firstly to the oppression of the poor – the humanity in the developing world; and secondly to technologists, and we include engineers in this category. The OXFAM Report provides many examples of the poor and the developing nations being oppressed by the globalisation that is occurring; in general they are not educated to critical awareness.

To change society we need to educate the oppressed so that they can seek freedom for themselves, we need to work with them, not do it for them. The role of the engineer then is partly educator; we need to bring critical awareness to the oppressed. This is a new role for many engineers. Currently a major focus of engineering education is on ways to maximise the business opportunities and to promote understanding of business principles. In an ethical engineering curriculum, engineers also need to learn how to interact with NGOs, focussing on ways to maximise the use of local solutions to local problems.

### **The Oppression of Technologists**

“Our advanced technological society is rapidly making objects of most of us and subtly programming us into conformity to the logic of the system. To the degree that this happens, we are also becoming submerged in a new ‘culture of silence’” (Freire, 1996).

In this context the system is the market, and current engineering education and practice, with its almost exclusive emphasis on the development of technical knowledge and skills, even more rapidly makes objects of most of us. Engineering in general, and many engineers, are caught in the trap of conformity to the logic of the system - the modernist engineer sees the world, its institutions as a clockwork machine. It, “the thing in question”, the objectifying word, is deeply embedded in our language. This is a controlling framework, and this oppression of people fits in with the current hegemony of the market. By controlling the performance of this machine (measuring output and input) and solving problems by using more technology, and by replacing people with technology, engineering practice becomes more and more like horology and less and less action for social improvement and at the same time, the engineering practitioner becomes more and more silent and more and more invisible. The educational practice that leads to this outcome is as much a victim of the oppressive dominance of the hegemony of the market as are the poor in this globalised world.

### **Beyond Oppression**

A change in educational practice is the only way forward. “As the ... person learns ... , the world becomes radically transformed and he or she is no longer willing to be a mere object responding to uncontrollable change.” (Freire, 1996) Engineering educators need to produce technologists who will look beyond the logic of the system, beyond the automatic responses... “the pedagogy of the oppressed must be forged *with*, not *for*, the oppressed in the incessant struggle to regain their humanity... Only as they discover themselves to be “hosts” of the oppressor can they contribute to the midwifery of their liberating pedagogy... The pedagogy of the oppressed is an instrument for their critical discovery that both they and their oppressors are manifestations of dehumanisation.” (Freire, 1996) We must begin with the education of engineers and engineering educators. Engineers and engineering need to discover themselves as “hosts” of the oppressor.

We must broaden the education of engineering to encompass not only technology but also the social, political and economic impacts of development. Engineering education must also make a paradigm shift into an eco-systemic understanding so that it becomes adaptive with the environment. It is the critical perception of limit situations as only fetters, rather than as insurmountable barriers, that is required of engineers and engineering to be able to act in ethical and sustainable ways in today’s globalised world.

We need to start to think of what we are dealing with as an eco-system not a market. The Market (and modern engineering practice) is monothematic and homogeneous – it is negative, inhuman, and amoral; whereas an eco-system is evolving, human, moral, diverse and heterogeneous.

Goricane and Young (2003) reflect on the nature of engineering practice when the project and its outcome are considered as an eco-system. This paper proposes a future for engineering where sustainability is deeply embedded in the things that engineering produces (i.e. its outcomes), in the way engineering is practiced (i.e. its operational processes and structures), and in the way engineers and engineering learn (i.e. its evolutionary processes). By examining the concept of sustainable engineering outcomes, in an environment which is fundamentally problematic, and then moving on to examine the necessary prerequisites for sustainable engineering practice, requires us to explicate the necessary adaptations in engineering education and institutional arrangements; the development of active adaptive engineering practice.

## Conclusion

Freire (1996) uses the term *conscientizacao* to refer to learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality. We need to teach our students to search for the sorts of contradictions in the world; such as those identified in the first sections of this paper. We also need to see ourselves as politicians – as in William's (2002) quote of Latour's definition of politics: the "progressive composition of a common world".

Williams (2002) argues that.."the sources of creativity necessary to engender change, technological or otherwise, flourish only in a setting with time and space for the intense social interactions that are at the heart of both research and learning." These same intense social interactions (educating to critical consciousness) that are at the heart of both research and learning need to occur when we, as engineers, are "doing it" to other people, other societies. When we are considering doing development for them we should instead be considering how do we engender change with them.

Freire sees education to be the way to freedom from oppression. We need to educate engineers to be reflective of what practice is and what it could be, so that they can see and act as educators of others. For Schon (1983), reflection in action distinguishes the truly outstanding professionals.

Using these ideas - that we are reflective, that we engage people in the creating of solutions for them, locally, that we allow time and space for engagement, that we pursue active adaptive engineering and use an eco-systemic view of development - we can make engineering practice meaningful, sustaining of life, and ultimately create a desirable and feasible future.

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