Engineering, Commerce and the Humanities: A Clash or a Synergy of Cultures?

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Abstract

The nature of, and relationships between Society, the University and University Academics are briefly explored. Three cultures, or broad disciplines, are seen within the university: engineering/science, humanities and commerce. In light of this, consideration is given to the manner in which the three disciplines interact. The development of modern scientific thought is assessed, especially the influence that the humanities have had upon science. The growing status of commerce in society, and the interdependence of commerce upon engineering, science and the humanities are also briefly reviewed. Modern universities are very vocationally oriented, and while this is good in the short-term, there is potential for universities to focus on producing work ready graduates rather than providing a broader education, as such, they are in danger of losing touch with one of the unique rôles they play in an increasingly secular world: that of "Critic and Conscience of Society". The human capital within the university is both extraordinarily knowledgeable and diverse, comprising the greatest concentration of scholars within a society. Unfortunately, the increasing specialization that is required of university staff has decreased interdisciplinary collaboration. The humanities are generally well insulated from science and engineering in discrete academic silos. Further, there is often minimal interaction between engineering and the sciences, let alone the arts… There are nonetheless opportunities, through which change may be effected, and this dissertation provides the rationale that underlies a successful, long-running course on professional ethics, wherein humanities and biological perspectives are being provided to undergraduate engineers in two countries.

What a piece of work is man!
How noble in reason!
How infinite in faculty!
In form, in moving, how express and admirable!
In action how like an angel!
In apprehension how like a god!

Hamlet (Act II, Scene ii,)

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William Shakespeare

1. Three Postulates:

Three primary postulates that underpin this essay are the nature of Society, the rôle and place of the university and the spiritual and intellectual nature of the individual. As it is within the higher education environment that any initiation of "cultural clash" is most likely to eventuate, it is the place of the university within the wider community that is particularly relevant to this discussion.

I. **Societies exist to perpetuate a values system:** Society exists to protect the values system of a group of people. Through these values, a particular society will develop its priorities, and these will be underpinned by its moral protocols. The protocols are enacted and delivered through various mechanisms, including government policy and the education sector.

II. **Universities exist to enhance the intellectual and moral perspectives of a Society:** The objective of a university extends beyond the development of a society's intellectual capacity to include a rôle as "Critic and Conscience of Society". Universities enshrine certain fundamental values, of which the most important is an absolute commitment to the pursuit of truth and knowledge. Thus university academics, through the exercise of uninhibited curiosity and engagement, can be expected to be very much involved in assessing the rights and wrongs of actions and proposals. This rôle is even more important in light of the deregulation of much of the infrastructure that was previously the domain of government, e.g. in bodies like local authorities.

III. **Human activity is informed by both the spirit and the intellect:** Whilst all human behaviour is predicated to some degree by the intellect, humans also have a spiritual side, although this may be manifested in diverse ways. Both intellect and spirituality are underpinned by values.

The essence within each of the above is values. However values are not constant, but in a state of flux, reflecting what is important to a particular society or individual at any one point in time. It has been argued too that "truth" is not a constant: John Henry Newman wryly remarked: "*Truth is the daughter of time. In a higher world it is otherwise, but here below to live is to change, and to be perfect is to have changed often*". Nonetheless, it is contended here that it is in the university environment that the flame of truth will burn longest, although it is within the university environment that many perceive the cultural clash is (and will be) the most apparent.

2. The Setting

Societies and civilizations are clearly not static. Recorded history shows that they grow, wane and ultimately fade into insignificance. The reasons for failure are well documented in history, and are in many cases a measure of a particular society's inability to adapt to

change, i.e. decline sets in when civilizations become rigid (Toynbee, 1946; Capra 1982; Freeman, 2003). An appreciation of mankind's journey to the present will hopefully help us from making the same mistakes, and thus prevent the human misery that arose from them. Paul Johnson (1991) puts it plainly:

> *The study of history is a powerful antidote to contemporary arrogance. It is humbling to discover how many of our glib assumptions, which seem to us novel and plausible, have been tested before, not once but many times and in innumerable guises; and discovered to be, at great human cost, wholly false.*

Understanding of this process is fundamental to education in the humanities. It is not so with engineering and science, and has not been so for at least a century.

The modern undergraduate engineering programme, comprising four years of full time study, struggles to find space to incorporate all the relevant advances within science, technology and design; in light of this, it is not surprising that there has been scant attention to how Western Society has contributed to the "evolution of the present" in the curriculum. Engineering traditionally involves adapting and/or harnessing the power of nature for the benefit of humanity. This is reflected in engineering heraldic devices – some of which actually celebrate domination of the natural environment, e.g. the coat of arms of the Institution of Professional Engineers New Zealand (see figure, wherein nature, symbolised as the sun, is restrained in chains).

The coat of arms of the Institution of Professional Engineers New Zealand.

The above "resource development focus" is complicated by the nature of engineering: the engineer is generally remote from the public – and this is in contrast to professions such as medicine, and law, where interaction with the public at a very personal level is the norm. As such, it has not traditionally been the business of engineering (and science) education to dabble with the humanities (Buckeridge, 2006a).

The word science is derived from the Latin *scientia*, meaning to know and it is the practice of science, achieved by employing objective principles, including empiricism, which advances the state of human knowledge. Engineering takes science a step further, through both application of science and design: as such, most of the infrastructure in the 21st Century although conceived through application of science, was implemented through engineering. Engineers are "left-brained" people. They are comfortable with logic, they utilise facts, enjoy order and visualise concepts in patterns. The core disciplines that they use to accomplish this are mathematics and science. Careful application of these disciplines makes them good engineers, and what they design and build is generally safe. In contrast, "right-brained" people are more likely to be imaginative: they will perceive things more holistically, possess a deeper understanding of history and language and make decisions more on the basis of feelings and beliefs. As

such right-brained people are more inclined to take risks. In academia, these right-brained individuals tend to gravitate to the humanities. There is a difference then, based upon genetics (and to a lesser extent environment), and this is demonstrated through what are often perceived as very different world-views. Some, like the polymath C.P. Snow, saw these two world-views as irreconcilable, such that Western intellectual life should be seen as comprising two mutually exclusive groups: i.e. literary intellectuals and scientists, and that these are separated by a gulf of mutual incomprehension. Snow made the following observation, which at the time set off a storm of controversy.

> *A good many times I have been present at gatherings of people who, by the standards of the traditional culture, are thought highly educated and who have with considerable gusto been expressing their incredulity at the illiteracy of scientists. Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics, the law of entropy. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: 'Have you read a work of Shakespeare's?'*
>
> C.P. Snow (*The Two Cultures*, 1969)

Snow was only partly right, because the system he described is almost certainly not bipolar. It is now possible to see three very distinct cultures: humanities, engineering/science and commerce. Commerce (or "business") slipped under Snow's intellectual radar, and this is almost certainly what the business world desired – to keep out of the argument. However, omission of the third culture was unfortunate: with hindsight we can reflect upon the vagaries of the current consumer society, where business is very much the dominant force. For example, in Australia over the last few months (of 2008), there has been growing concern about the manner in which the public is being manipulated by the "media". Subliminal advertising had been incorporated into a number of television programmes, without wide awareness that it was being utilised. The objectives were clear – to increase sales by convincing consumers that they should buy goods that they had not considered purchasing – and probably do not need. One may ask: "what has this got to do with either science/engineering or the humanities?" Actually it has quite a lot. The selling is achieved through some very sophisticated psychology (a synergy of science and humanities) and it is delivered through remarkable engineering. But who is to blame? Surely the engineers, scientists and sociologists were simply manipulated (or bought) by businessmen? Consider Tom Lehrer's satirical jab:

> *When the rockets go up,*
> *Who cares where they come down?*
>
> *That's not my department".*
> *Says Wernher von Braun"*
>
> Lehrer, T., *That was the Year that was* (1970)

Can we expect the engineering world (or the humanities) to accept blame when they are somewhat removed from the action? How is blame to be apportioned - if indeed it is to be apportioned? Can society expect accountability from professionals (of any discipline) when something goes awry? If “yes”, then how should any accountability be assessed, quantified and enforced? Recent media comment on the extraordinary salaries of executives in the commercial sector has been defended as simply reflecting what the market will bear. Clearly the market, at least in recent years, has not borne these salaries well. Nonetheless, these business leaders certainly consider themselves “professionals” and as such the public has certain expectations that they will behave as professionals. That the multimillion-dollar payments and golden handshakes many senior executives receive (or have received) are both unwarranted and unsustainable is now abundantly clear following the 2008 stock market collapse.

Other professions, including engineering, have addressed the need to ensure professional behaviour through codes of practice, and over the last half-century, these have been upgraded as codes of ethics. Many of these are standardised through international protocols such as those promoted through the World Federation of Engineering Organizations and the International Engineering Alliance (i.e. Washington Accord). There is status in being a professional, and this status is afforded by the public in recognition that professionals will behave with honesty and integrity – i.e. in an ethical manner where decisions are not simply done for the betterment of those immediately impacted by an activity.

The Engineers Australia code of ethics has the same basic structure as other professional engineering bodies within the Washington Accord (1989). It comprises nine tenets (or protocols), designed to ensure that engineers behave competently, honestly and fairly and undertake ongoing professional development. As members of the Institution of Engineers Australia, professional engineers are committed and obliged to apply and uphold the Cardinal Principles of the Code of Ethics.
These are:

- to respect the inherent dignity of the individual,
- to act on the basis of a well-informed conscience,
- to act in the interest of the community.

These three principles revolve around the value that we place on rights – both of the individual and of the community; they are encapsulated within and established by the following Tenets of the Code of Ethics:

1. *Members shall place their responsibility of the welfare, health and safety of the community before their responsibility to sectional or private interests or to other members.*
2. *Members shall act with honour, integrity and dignity in order to merit the trust of the community and the profession.*
3. *Members shall act only in areas of their competence and in a careful and dignified manner.*
4. *Members shall act with honest, good faith and equity and without discrimination towards all in the community.*

5. *Members shall apply their skill and knowledge in the interest of their employer or client for whom they shall act with integrity without compromising any other obligation to these Tenets.*
6. *Members shall, where relevant, take reasonable steps to inform themselves, their clients and employers, of the social, environmental, economic and other possible consequences which may arise from their actions.*
7. *Members shall express opinions, make statements or give evidence with fairness and honest and only on the basis of adequate knowledge.*
8. *Members shall continue to develop relevant knowledge, skill and expertise throughout their careers and shall actively assist and encourage those with whom they are associated to do likewise.*
9. *Members shall not assist in or induce a breach of these Tenets and shall support those who seek to uphold them if called upon or in a position to do so.*

It is the first and sixth tents that are worthy of discussion here: the first tenet requires engineers to place the welfare, health and safety of the community *before* their responsibility to sectional or private interests or to other members (italics mine) and the sixth focuses on the need for engineers to inform themselves and to communicate effectively with interested and affected parties. Importantly, the manner in which these tenets are promoted (both within and outside the profession) is transparent. The manner is also succinct. A cursory survey of web sites of codes adopted by some in the commercial world (e.g. Professional Accountants of Australia, Commerce Bank, USA) shows that there is a propensity to be over prescriptive – to the point of even providing guidelines as to whether one may take home pens from the office. The accountant's code is 73 pages long! Further, in neither code were any "high level" ethical aspirations clear: while they were very much concerned about conflict of interest and theft, any duty to society and the environment, such as in the engineer's first and sixth tenets, was not apparent. There is a gulf here too then…

In the late 1980s, Capra (1982) concluded that if Western Society is to survive, it will need to distance itself from the reductionist approach that allowed so much progress in the last millennium. The reasons for this were well articulated in 1962 in Rachel Carson's book *Silent Spring* (Carson, 2002), and demonstrate that humanity had become just too good at manipulating nature. The outcome has been the disintegration of global systems that we are experiencing today. A paradigm shift toward holistic or systems thinking was identified as being an appropriate response (Brundtland, 1987), and fortunately this approach is becoming widely adopted in engineering curricula. Concurrent with the change in engineering curricula are some extraordinary developments in the humanities: there is widespread acceptance that sociology is too imprecise (or insufficiently grand), such that it has been transformed in many universities into social *science*; even more extraordinary is the proposed move for history departments to abandon the traditional holistic roots and to become reductionist (Windshuttle, 1994).

It is worthwhile reflecting upon the changes that have occurred in engineering education over the last few decades. Although orchestrated within the profession, much

of the impetus for these changes was generated by developments outside the profession: These drivers of change are the visibly degrading environment with biodiversity under threat, a steadily increasing human population with a commensurate depletion of natural resources, and increased uncertainty with climate systems. That our biosphere is under threat is no longer in contention, indeed, the current crisis has been significantly exacerbated since Carson first focused our attention on it in the mid twentieth century.

One way in which the international engineering profession has responded is through a series of agreements that aim to benchmark engineering degrees in different countries. The first of these, the Washington Accord, was signed in 1989, and serves to facilitate movement of engineering graduates in the global market. Originally the Washington Accord had signatories only from Anglophone nations, but this is now rapidly expanding, with Chinese Taipei, Germany, India, Japan, Korea, Malaysia, Russia and Sri Lanka now formally linked. Benchmarking is achieved through professional accreditation of degrees and the departments that offer them (*see* Buckeridge 2006b), and in addition to ensuring that graduates possess appropriate technical competence standards, it is required that graduates will also have a comprehensive understanding of, and commitment to professional ethics and responsibilities, and norms of engineering practice (Buckeridge, 2002; Buckeridge and Grünwald, 2003). Ethics may be defined as the implementation of morality in professional practice – i.e. it will reflect the values of society at a particular time and place. Societal values are, however, never fixed. Traits that Aristotle would have considered virtues some 2,300 years ago, such as swordsmanship of a hoplite soldier, are not easily transferred to the 21st century as a "good" (*see* Aristotle, 1987).

Engineering and science are derived from humanity's ingenuity, i.e. they are products of society and as such must function within the constraints of good social practice. As such, technology should be the servant of society, not the master. Gandhi's elegant quote, that science without humanity is a cardinal sin, informs us that any gulf between technology and humanity should be seen as anathema:

> *If science becomes all technique and technology, it quickly degenerates into man against humanity. Technologies come from the paradigms of science. And if there's very little understanding of the higher human purposes that the technology is striving to serve, we become victims of our own technocracy. We see otherwise highly educated people climbing the scientific ladder of success, even though it's often missing the rung called humanity and leaning against the wrong wall.*
>
> Mahatma Gandhi (*The Seven Deadly Sins*)

Engineering professionals (along with other professionals in commerce, science and the humanities), do not function within a vacuum. From an engineering perspective at least, the continuum between ethics, morals and social values provides the best argument for inculcation of social, economic and biological perspectives within the curriculum (*see* Buckeridge, 2008).

3. Engagement of the Scientific Mind:

It can be argued that science began with the Greeks, although the empirical approach was not confirmed until the late 17th Century, when Isaac Newton unequivocally demonstrated that the physical properties of objects could be derived through experimentation. Before Newton, the foundations of science were laid by Nicolaus Copernicus (1473-1543) and Galileo Galilei (1564-1642) who together provided the intellectual framework for Newton's understanding of motion and gravity, and Francis Bacon (1561-1626) who amongst other achievements formulated scientific induction. The relationship between science (including engineering) and the humanities (including religion) was awkward – even Newton had difficulty with aspects of his religious beliefs, which he tried to rationalize in his work on biblical hermeneutics. This is not surprising as in Newton's time, Europe was still strongly influenced by medieval religious dogma – and this is encapsulated in the work of the 13th Century mystic Saint Thomas Aquinas, who even today is remembered for his synergy of medieval science with a deep Christian faith.

In the 1950s, the elegant mechanical nature of the universe, demonstrated by Newton, was shattered by Albert Einstein and Werner Heisenberg, who were able to show that science is not as precise as we had been led to believe (Heisenberg's uncertainty principle of quantum theory). The knowledge that the world was not as we had hoped probably has little effect on our day to day living – we still function, for the most part, under Newtonian Laws, but the fundamental underlying truths in science (and engineering) were clearly in question, and still are, more than half a century on. The uncertainty in science should not however be seen as imprecision, for our understanding of the nature of the world around us has been achieved through very precise and complex mathematics and engineering. It is the complexity of the science, and the inability of the average person to understand the concepts, that is distancing much of science from the humanities and commerce.

It is the task of scientists and engineers, through effective communication, to bridge this gap.

4. Putting Humanity into Engineering:

The human capital within the university is both extraordinarily knowledgeable and diverse, comprising the greatest concentration of scholars within a society. Unfortunately, the increasing specialization that is required of university staff has decreased interdisciplinary collaboration. The humanities are generally well insulated from science and engineering in discrete academic silos. Further, there is often minimal interaction between engineering and the sciences, let alone between engineering and the arts and commerce.

International agreements such as the Washington Accord made it mandatory to inculcate ethics into the engineering curriculum, with failure to undertake this to a professionally acceptable level resulting in accreditation for the degree programme being withdrawn. Although the imperative for developing effective engineering ethics education became clear in the 1990s, the mechanism through which it should be done

was not. As noted above, engineers have a particular mind-set, as they tend to be comfortable with numbers rather than words. That is why, when leaving high school, they chose to study engineering. Ethics, along with logic, are the branches of philosophy, and although philosophy was conceived within the Greek scientific framework, for the last few centuries it has existed within faculties of arts (or humanities). Introducing philosophy to engineering undergraduates was a challenge: it needed to be provided within an "engineering context", but it also needed to include human and environmental perspectives.

It was quickly seen that the greatest likelihood of success would be if the major part of the course were delivered through case studies, although this did not negate the need to provide instruction in the language and analytical tools of philosophy at the start of the course.

5. The RMIT-Wismar Benchmarking Model:

At the time the Washington Accord was signed (1989), there were few pedagogic models available for the teaching of professional ethics. The response taken by many schools of engineering was to adopt a similar strategy that which addressed another long identified shortcoming of engineering graduates: that of poor communication skills, with the standard solution being utilization of academics from English Departments. This move generally appealed to university management, as it minimised duplication of systems and gave a much-needed boost to the viability of humanities schools in general. The outcome however, was not always as anticipated. The mindset and pedagogy used by teachers from a humanities background clashed with the engineering environment: in particular, the style of report writing for engineers is at variance to that in literature, e.g. the language needed to be direct, unembellished and unambiguous. As with many elegant solutions – especially those undertaken remotely, the two cultures clashed. What was taught was not in accordance with engineering needs, and students responded with strong criticism (Buckeridge and Grünwald, 2003). The solution was clear, with an imperative to contextualize any ethics within the engineering world-view, and this demanded that engineers teach the subject. The outcome was a new, dedicated block-course on engineering ethics: "Ethics and the Professional".

Measuring the effectiveness of the RMIT-Wismar Model: The course "Ethics and the Professional" has been taught at both RMIT University (Australia) and Wismar University of Technology Business and design (Germany) since 1999. The course does more than simply teach engineers about the humanities: it provides an international benchmark for our senior undergraduate programme. In addition, the German model has in the last five years taken a further step, for as well as providing the learning environment in the English language, students from other backgrounds have been invited to participate in the course, e.g. from the faculties of Architecture and Business. This has been reflected in consistently positive student feedback at Wismar.

In Australia, universities have adopted a more-or-less standardized course evaluation survey of 21 questions. These surveys are undertaken by students on the final day of the course and provide feedback on a range of issues, such as facilities, pedagogy and the structure and timing of the course. Assessment of the pedagogy is a measure of

the ability of the lecturer to provide the best possible learning environment, and is calculated by six questions converted into a good teaching scale (or GTS), with the maximum GTS being 100. Since surveys have been undertaken on this course, the GTS has been consistently in the low 90s (this compares very favorably with the RMIT University average GTS of 46-47 over the last few years).

On 25 July 2006, the Victoria State Government passed the Charter of Human Rights. This charter will ensure human rights are valued and protected within government and the community. In its founding principles, the charter states that all people are born free and equal in dignity and rights. It is now a requirement for the workplace to implement the charter and in response this, a Federally funded Centre for Human Rights Education was established at RMIT University, with a focus on the delivery of a platform of post-graduate programmes for managers in business and industry. Importantly, the programmes are taught by a wide range of senior academics from various disciplines, including science, engineering and humanities; this was stipulated by the university's Vice Chancellor in light of the multi-disciplinary backgrounds of the clients. A measure of the success of the engineering course "Ethics and the Professional" is its incorporation into these programmes. Teaching in the programme also gives academics from various backgrounds the enriching, and enjoyable experience of working together.

6. Bridging the Gulf of Incomprehension:

There is a gulf between the three major cultures – and this is no more apparent than in higher education. Nonetheless, there are healthy trends that are reversing this, with the driver for reform including issues such as global warming, the degrading environment and legislative changes. To ensure that there will be a more equitable and a habitable world for future generations, humans will need to adopt a more holistic system of natural and human resource management. Perhaps surprisingly, it is engineering, rather than other disciplines that is currently showing the way (Buckeridge, 2006a). But engineers are resourceful, and this should give us hope.

Bridging the Gulf: *A little rickety perhaps, but it has been there for centuries. A bridge-house in Wismar, northern Germany. Conceived through human necessity, implemented by design, sustained by commerce and augmented by engineering!*

A progressive university that is aware of the implications global change, and that takes cognisance of this in its course offering, provides a unique opportunity to

bridge the intellectual divide[2]. In pursuing this objective, it will provide outcomes that will benefit the wider community, and as such will be able to demonstrate that its learning truly extends beyond the walls of academe, to impact upon us all – as critic and conscience of society.

7. Epilogue:

This dissertation opened with a quote from William Shakespeare's *Hamlet*, published in 1602. Perhaps it gives us reason to be proud of ourselves as humans. The few lines that follow the above quotation are, however, not so often included. Nonetheless, they should give us pause to reflect:

> *And yet, to me,*
> *what is this quintessence of dust? man delights not*
> *me: no, nor woman neither, though by your smiling*
> *you seem to say so.*
>
> *Hamlet* (Act II, Scene ii,)

Biodata:

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[2] RMIT University recently established a multidisciplinary Research Institute, "Global Cities" which it is hoped will facilitate this process.

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