
The Role of a Center for Liberal Arts in Engineering Education: the Engineer of 2020*

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Much has been written about the two-culture conflict, as described by C.P. Snow. However, another and more devastating *two culture conflict* is found between engineers and partisans of liberal learning. This has not always been the case and, fortunately, is being overcome in our time. The National Academy of Engineering's paper calling for the reform of engineering education in anticipation of the needs of society and industry in the year 2020 articulates the need for greater education for engineers in the areas generally classified as the liberal arts. In this article, it is suggested that curriculum reform of the sort encouraged by the NAE, while laudatory, is insufficient to address the urgent needs of a global society. The integration of engineering and technological training with the liberal arts is discussed on a philosophical level, proposing that the goal of integration can only be achieved when both the liberal arts and engineering are reconsidered as specifically *human* disciplines. It will be the work of the newly founded UICEE satellite centre, the *Center for Liberal Arts in Engineering Education* (CLAEE), to lead practical research in this field. The task is vital and crucial to the future. It will require the rethinking of many cultural, scientific and educational paradigms. This research, conceived as *crisis philosophy*, will be in the spirit of Hans Jonas' *imperative of responsibility*.

INTRODUCTION

It is now axiomatic that engineers need the benefits traditionally provided through the process of liberal education. Indeed, the National Academy of Engineering's strategic paper, *The Engineer of 2020*, valorises the humanities and social sciences, communication and presentation skills, and business management science as of greater – or least equal – importance to technical subjects for the professional engineer [1]. This is a new view of engineering. Indeed, it is this emerging view of the engineering profession, as always being revised by history and circumstance, that gives urgency to the work of a *Center for the Liberal Arts in Engineering Education* (CLAEE), which was

recently established at Polytechnic University in New York, USA, as part of the University's partnership with the UNESCO International Centre for Engineering Education (UICEE).

It is the task of the Center to ask, in light of this seismic shift, *What precisely is it that the engineering profession expects from this expanded curriculum?* and *What is the purpose of requiring liberal arts education as part of the professional training of engineers?* It might also be asked conversely: *What value does engineering give to the humanities?* These obviously related questions are usually thought to have asymmetrical answers, or at least answers on different plains of discourse. The study of nature, chemistry, physics and biology or theoretical mathematics, and other such disciplines, is, of course, an important part of a liberal arts education. While the *two cultures* of C.P. Snow may persist, it is pretty much of a family fight: scientists think English majors should learn more mathematics while humanities professors often disdain the unsophisticated reading of the literary classics that their science colleagues assert. But with engineering,

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the case is different; there is distance that almost makes argument impossible. Polytechnics, until recently, were not considered universities, and their commitment to the traditional *trivium* and *quadrivium* became marginal at best. To understand the status of the liberal arts within contemporary engineering education, therefore, it is of no value to revisit the *two culture* debate as the mutual condescension has not been grounded on a dispute about how much of the *other* is necessary or how an education is complete, but rather on something more like the discussion that would ensue if someone were to question the appropriateness of the differences in the preparation required for a member of clergy and an auto mechanic.

THE LIBERAL ARTS

To be clear, we should define the liberal arts, the presumed heart of a liberal arts education, and from the perspective of the liberal arts. This is not as obvious or easy a task as it might seem. Many discussions of liberal education exist and most are focused on the values of liberal education rather than on the specific course of study that comprises a liberal education. At one time, Latin was *sine qua non*, whereas today most educators would suggest that other subjects are more suitable to the task of achieving liberal education. Indeed, liberal arts education, ahead of its time, was to be measured by outcomes. And, to use another contemporary expression, the liberal arts represented the *value added* to that created by practical skills such as arithmetic, elocution and grammar.

While these particular disciplines actually represent the *seven liberal arts* of the *trivium* and *quadrivium*, today they are understood to be only the basic foundation for liberal learning. Thus, the tools of literacy are not equivalent to the contemporary version of liberal arts. Today presentations and technical report writing are not true liberal arts courses. Disciplines such as English (literature), history and philosophy are usually cited as paradigms of the liberal arts. In engineering schools, the term *liberal arts* is generally not used so these disciplines find their home in departments of humanities and social sciences. The social sciences, such as economics and psychology, are generally seen to be part of the liberal arts, primarily because their subject matter covers human studies that existed prior to the advent of social science. Roughly speaking then, the liberal arts curriculum is what is also called the humanities or the humanities and sciences or, most generally, what is taught in faculties of arts and sciences. In this article, the discussion focuses on the traditional humanities.

Faced with this realisation – that the liberal arts do

not primarily train individuals in the practical arts such as effective communication – the expectation of measurable outcomes becomes problematic. What would one expect to find in an engineer who had been introduced to the liberal arts that one would not be likely to find in one who had been taught communications skills and social science, but lacked the humanities? This turns out to be a classic question, one that preoccupied Plato among others who were concerned with the proper education needed to instil the best mixture of technical skill, civic virtue, intellectual eros and practical wisdom. In these reflections, the purpose is not to reprise the classical discussion, but to suggest that a distinctly new approach must be articulated to account for the rise of modern technology.

To frame the issue, consider this: will the world solve the problem of global warming or climate change before devastating consequences alter severely the very basis of human life? We can perhaps agree that there are grounds to be pessimistic. But are the reasons we feel in jeopardy due to a lack of scientific knowledge or technical skills? To some extent, the answer is yes. But although our knowledge is imperfect and our technology limited, it is no doubt the case that the problem of irreversible and devastating climate change could be meaningfully addressed. We know how to limit greenhouse emissions even if we do not know exactly how greenhouse gasses distribute themselves globally. We know that a tipping point will soon be upon us even if we cannot calculate (or disagree on our calculations) when that point will occur or how steep the slope will be. In other words, our science and technology, however imperfect, are sufficient to prevent the most dire outcome, yet it remains likely that we will experience the disaster of the most dire outcome. Why?

CLASSICAL ELEMENTS OF EDUCATION

Let us reflect upon the elements of education as cited above.

- Technical skill;
- Civic virtue;
- Intellectual eros;
- Practical wisdom.

Technical skill refers to control and implies the power to control. A process, aided or unaided by tools or machinery, leads, with a high degree of reliability, to a changed state. The new state is stable and does not unleash unpredicted or uncontrollable consequences. Classically, technical skills were classified either as making or performing arts, the arts of the

potter and the archer, ie those that left a product and those that were controlled and time-bound processes only. All technical skills were for the sake of something and the art was called upon only in the service of those external *somethings*.

Civic virtue was that excellence that permitted people to live together in common enterprise. The proper means for the cultivation of this quality was always a matter of controversy, as it depends on one's view of human nature. Socrates argued that knowledge of the good was sufficient to propel one in that direction. Aristotle did not think intellectual understanding was sufficient, even when it was possible, but that measured habituation had to be promoted. A similar debate was waged in ancient China where Mencius argued that humankind was by nature good and Hsün Tzu maintained that good behaviour only resulted from enforced discipline. St Paul famously asserted the polar opposite of the Socratic view, precisely that the more one knows the good, the less one is likely to seek it. One can easily conclude that the development of technical skill was a far easier task for the pedagogue than the cultivation of civic virtue. This is due partly, of course, because there is easier agreement on what actually constitutes technical skills whereas the characterisation of virtue is far more elusive. *What is the good?* and even *Is there good?* are far more difficult questions than whether a process is efficient or precise. The latter investigation does not seem to require genuine knowledge – or at least knowledge of the same order – as such comprehensive questions as the reality of the good or the nature of humanity. For these questions, one must ask *What knowledge is needed?*, *What is knowledge?* and *How is knowledge measured?*

Let us say and then return to it later that civic virtue is a matter of philosophy and technical skill is a matter of poetics.

Intellectual eros is a notion that may not survive in our day. According to Plato, *The feeling of wonder is the mark of the philosopher, for all philosophy begins in wonder*, a view echoed by Aristotle in his *Metaphysics* in which he begins, *All men by nature desire to know. An indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves...* For Aristotle, it is characteristic of human beings to desire to know and understand. Wisdom, understanding and knowledge, venerated in many traditions, are considered ends in themselves, desired for their own sake in sharp contrast to technical skills, which are always for the sake of something else. Intellectual eros begins in the attraction to particulars and ascends to the eternal and universal. The result

of this eros should be wisdom, ie the condition that underlies good judgement and discernment. The question for education in our time, given the complexity of our world and our ability to promulgate change that we cannot reverse or undo, is how are judgement and discernment even possible. Given the fetishistic and co-modified construct of experience prevalent today, the very notion of intellectual eros seems quaint.

Practical Wisdom, on the other hand, however elusive, is highly valued. Called by many names it is what business schools, engineering colleges and most professional programmes promise. Indeed, liberal arts colleges, in their perpetual effort to fend off criticism of them as archaic, proclaim their curricula to be the true path to practical wisdom. Practical wisdom comes from mentoring; something like an apprenticeship that goes beyond technical skills to prepare superb generalists ready to solve whatever problems face them. Indeed, this is the putative *value added* mentioned above.

Let us return to the question, *What form of education is necessary to ensure adequate stewardship of the future?* The answer is simply stated: education that overcomes the mutual hostility sustained both by engineers and the guardians of the liberal arts, combines the four elements just defined and is the type of education available for the many.

One might, with justification, say that the primary function of a Center for the Liberal Arts in Engineering Education is to serve as an honest broker or negotiator between the hostile parties.

To overcome the hostility born of entirely different educational value systems, the four elements must be combined. This act requires a rethinking of the notion of *technical skill*, which brings us back to philosophy and poetics. Hannah Arendt imaginatively addresses this topic throughout her authorship as she sought to show the relevance of Greek political thought to contemporary issues. Poetics is mimetic while philosophy is discursive. The ideal mimesis is the work of the ultimate artisan or technician, the *ideal* being precisely the *perfect* exemplar. The artisan or technician is a copyist, aiming to reproduce the exemplar. The only non-technical question is which ideal to reproduce. It is this that gives poetics its tenuous claim on truth, but as Plato has Socrates point out on numerous occasions, the criterion for knowing the truth is absent from the procedures of poetics. Philosophy, on the other hand, is the dialogical/dialectical process of approaching the truth. The quest is to be undertaken without presuppositions and the procedure is assumed to be self-guiding. Socrates says questions need to be asked in the *correct* order without explaining the algorithm defining this order.

Thus, it becomes clear why poetics needs philosophy and vice versa. Poetics represents pure technique or method, what philosophy lacks completely. Likewise poetics needs philosophy if it is to approach the truth. Arendt recognises many modern attempts on the part of poetics to appropriate the philosopher's task, none of which in her estimation succeeds. But this is the task before us.

ENGINEERING AS POETICS

Let us call philosophy the liberal arts and poetics engineering education. The first objection to this equation is that engineering is more than mere imitation. This objection rests on the assumption that modern engineering is scientific and that principles from the natural sciences and mathematics are themselves intrinsic to engineering. This is not the case, however much an engineering solution makes use of science. Science, *scientia* or *episteme*, knowledge – indeed reason itself – is much closer to philosophy than it is to engineering. Bad engineering lacks knowledge but is still engineering. The questions are *How should knowledge be used?* and *What knowledge is worth having?* These questions are the questions of philosophy or the liberal arts. It turns out that some answers to these questions necessitate engineering. In fact, the questions themselves would not be possible without engineering.

It is clear on this analysis that in the world where we have the power to initiate profound and irreversible change that the choices borne from philosophical reflection, however scientifically well informed, are no more than impotent cries without the enabling techniques we call engineering. Conversely, engineering choices based only on such criteria as efficiency and durability are likewise unable to steer us towards desirable ends.

If we return to our meditation on the reasons for global warming and our pessimistic prognosis that a disastrous outcome is likely, we can see how a positive relation between the liberal arts and engineering could have produced a salutary conclusion.

The discourse of engineering needs to be expanded. The iterative methods, the insistence on quality control, the inherent pragmatism, as well as the responsiveness to expressed needs and articulated problems, all make the practice of engineering the optimal rationalisation of human action. This is to say that engineering is the exemplary human art, the art that allows us to be effective and to achieve desired outcomes. What is crucially missing from engineering is the critical means to evaluate and place into a calculus of human good the many desires that present themselves to us.

As the optimal rationalisation of human action, engineering comes closest to achieving the means for the age-old aspiration to control our destiny or manage our fate. In this regard, it is important to distinguish between human action and human behaviour. In the West, action is understood to differ from behaviour in that action is something we choose to do, that is we are free to do or not to do in contrast to those behaviours that we do from sheer necessity. That is to say action is the manifestation of some sort of deliberation over what we would prefer and could, at least in a physical sense, do without. Behaviour can be more or less automatic, a response to a stimulus, or generated in situations where deliberation is not plausible as is often the case in situations of danger.

Engineering, of course, deeply influences behaviour. For example, the infrastructure of a city to a large degree preordains the kind of behaviour possible during an event like a flood. But this is not to say that the behaviour is itself engineering. Engineering perceives a problem or an obstacle to free human expression and through a process of adaptation, calculation, and trial and error creates, designs, implements and operates an overcoming of that problem or obstacle. Successful engineering in such instances thereby defies fate or destiny.

If religion begs for redemption or a different destiny, poetry sings celebrations or lamentations prompted by our conscious awareness of what the future may hold for us and philosophy seeks to understand whatever meaning attends our fate, engineering fabricates an alternative.

Thus, a symbiotic collaboration of the liberal arts and engineering, of philosophy and poetics, is an imperative. Plato's political philosophy sought to banish the poets from the city which, in order to be just, was to benefit from the rule of philosophy. It is perhaps this stark separation by Plato of the life of the mind and its potential to capture the good and the technical artificing of beauty by poetry and the other mimetic arts that is the foundation for the divide between the liberal arts and engineering. But just as the liberal arts were able finally to embrace poetry and other fine arts, can we not now imagine the inclusion of engineering within that collective?

The embrace of poetry came about, of course, partly because poets and philosophers have traditionally been interested in the same things. It also has to do with meaning of pleasure as Aristotle suggested. If the liberal arts were to *liberate* us from our slavish dependence on the here and now, surely they become the basis for enduring pleasure. But poetry is perhaps the most pure expression of pleasure and as such shares the same *raison d'être* as the liberal arts. So poetry

has finally been granted residence in the camp of the philosophers. Are the grounds for admitting engineering similar?

If it is the case that engineering is the human art par excellence, and not, as some assert, applied science, then the case can be made on essentially the same platform. For engineering is concerned with the human prospect and with the liberation of humanity from the slavery of repetitive, mechanical tasks. This liberation or redemption is indeed pleasure.

Engineering is widely misunderstood to its own disadvantage, as well as to the detriment of the well-being of humanity. The latter is the case because many engineering disciplines have been excised from the liberal arts curriculum in a manner reminiscent of Plato's banishing of the poets from the good city. If Karl Popper is right and Platonic *eidetic* political thought contains the seeds of fascism and totalitarianism, and if the corrective of piecemeal engineering can save it from that fate, then is it far fetched to say that the methods and values of engineering practice might likewise preserve the liberal arts as a beacon for our times?

MISTAKEN SOLUTIONS

Contrary to the view of some contemporary behaviouralists, politics is deeply philosophical. Consider the question of the best regime. Any discussion of the types of political regimes involves the question of what it is best suited for. What is it for the sake of? There are competing answers, but they all generally allude to justice, economic well-being, safety and security, and preserving the good of the present for the future. So the fundamental political question is what type of regime best serves those ends.

If we extend the possible types of regime along a continuum, the extreme left will locate anarchy and the far right absolute monarchy. That is, the continuum ranges from no rule to the unconstrained rule of one. Now where on this line should we expect to find the best type of regime? It will be at that point where the ends mentioned above are best served. But this answer certainly begs the question; the true solution certainly is a function of how humanity responds to such rule – and this question is the question of human nature. Politics rests firmly on philosophy.

The argument so far has asserted that engineering is the concretisation of a poetics that is reconciled with philosophy.

The misunderstanding of engineering, both by those who dismiss its value and those who exaggerate it, is helping to create a mistaken and unfortunate reshaping

of university curricula. There are at least three mistaken tendencies gaining support globally in both comprehensive and technical universities, specifically:

1. Replacing the traditional liberal arts with skills-based communications courses, the study of management, the development of entrepreneurial tendencies, and something called leadership training;
2. The mutual assimilation of engineering and natural science into such hybrids as nano-science, a compromise to both pure inquiry and practical problem-solving;
3. The conversion of engineering education into preparation to be part of a technocracy in the service of capitalism.

Each of these approaches has something sensible to recommend it. However, it should be obvious that the meaning of being human is lost from each of these approaches to education. The motivation behind this tendency derives from the prevalent and narrowly utilitarian approach to higher education that measures learning outcomes only in terms of defined career objectives. These days, a university may validate its curriculum and culture by the number of CEOs or ranking government officials it counts among its graduates. No one doubts the proposition that universities should be an important source for society's creative leadership; the problem emerges when one tries to teach specifically towards this goal and when the conception of what is needed is closed.

Engineers have generally been efficient, compliant and intelligent members of the workforce. They recognise opportunities and will act to realise them. As technology becomes ever more important to business and government, those skills possessed by engineers become essential. Technology management is often the key element defining an organisation's success or even survival. Each of the above cited tendencies aims to produce technology managers – or at least labourers – in well-managed technology driven organisations.

Liberal arts graduates, on the other hand, rather than being efficient and compliant, are likely to be reflective, deliberative, and perhaps dissident. Moreover, they are typically only minimally trained in the use of contemporary technology and are not prepared to manage technological systems.

Thus, from the point of view of the global job market, the ideal education turns out to be engineering modified to include technology management. The three tendencies above correspond to a three-tier approach to education as follows:

1. *Liberal Arts* programmes designed to produce literate employees who are *nimble* and prepared for ongoing professional education to *upgrade* their useful skills. This type of education includes basic engineering and technology, but does not aim to produce top design engineers;
2. Programmes in the *cutting edge* new technologies that exploit basic scientific research to train *new engineers* to create high-technology products;
3. Technology management programmes.

It is clear that the traditional aims of liberal education are all abrogated in the above approaches. But it is also clear that a traditional liberal education will not prepare individuals for the world as it now exists. What is needed?

The debate will continue about the purpose of, for example, English literature, history and philosophy, in a four-year programme. The questions about mathematics and natural science, at what level and which topics, will intensify. What about communications skills, ESL, technical presentations and writing, foreign language instruction? Which social sciences – economics, psychology, sociology – are essential? How should education address politics, multicultural issues, aesthetics, ethics and other value disciplines? And, of course, the question of how much and which technologies need to be incorporated into the curriculum will continue to vex us.

GLOBALISATION

These kinds of questions will and should lead to a variety of solutions. There will be local determinations; what is possible and appropriate in New York, Mumbai and Shanghai will not be the same. But we need to be able to discern what elements of education should have a high degree of uniformity around the globe and which, on the contrary, should resist as powerfully as possible the levelling process of globalisation. In his recent book, *The World is Flat*, author Thomas Friedman seems to celebrate this levelling [2]. Yet the loss of cultural diversity and the potential for creative problem solving it represents would be tragic.

Many problems are global; perhaps the most crucial problems are. Genuine understanding of the impact of such problems requires international cooperation and agreement. Education must prepare individuals to discuss and take action in the midst of ongoing global crises. Such preparation consists in the development of dispositions and mindsets that are open, imaginative and, most importantly, able to see issues from alternative viewpoints and under various sets of

categorical assumptions. In the end, education is not a set of courses or projects that have specifiable and quantitatively measurable outcomes. Education must leave room for serendipity, for awakening, discovery and especially for love and commitment. Perhaps these qualities best reflect what modern liberal education, the conjunction of philosophy and poetics, is really all about. Such an education can and must be rooted in tradition and, indeed, in the soil of several traditions; it should also be simultaneously open to whatever the future offers. It is chauvinistic to think that such education is not global.

CONCLUSION

The engineer of 2020 should be a citizen of the world of 2020. We cannot afford to continue the destructive bifurcation of education that places the school of liberal arts and the college of engineering on opposite sides of the campus. The kind of education needed, call it engineering education if you will, is global both in its comprehensive or holistic approach to reality, as well as in its honest acknowledgement of world geography.

The imperative we now face, with very little time before us, is to imagine and enact an education that is commensurate to the realities leading us into the world of 2020.

The work of the UICEE satellite centre, the CLAE, should not and cannot be limited to the Polytechnic University. The problem is fundamental, global and ubiquitous. We will seek funding to support research that expands the discourse of engineering and articulates the common ground engineering and the liberal arts have as primary *human* disciplines. The crisis of global warming is surely only a harbinger of what will be the other crises that threaten life on earth. Only when humanists become engineers and engineers become humanists can we hope for a secure future.

The first phase of this research will manifest a *crisis philosophy* to engender the praxis and action necessary to address the manifold challenges pressing upon us. Whether the crisis is energy, transportation, housing, sustainable cities, water, environmental pollution, secure utilities, pandemics, or any of the numerous modes of terrorism, solutions can only be achieved when engineers become engaged as humanists and humanists learn to focus and aim their creative and critical skill at actual, material problems. We all know that this must be undertaken, but it is nevertheless the case that we are not well prepared to do so; in a profound sense, we do not know how to do so. It is the task of the CLAE to help create the

Weltanschauung that can actually move us to action. It must be a *world-view* in all senses of that term. It must be comprehensive, open, global, and systematically articulated and organised. It will be both an analysis and a manifesto that emerges from extensive dialogue among participants representing the diversity of global constituencies.

This is the most important task to be faced. We can no longer live adhering to parochial versions of reality, be they cultural or scientific. We must, contrary to Hume's doctrine, conjoin the *is* and the *ought*, the *what we have right now* and the *what we must demand for the future*. It is only through the integration of liberal learning and engineering techné that we can manage what, in Hans Jonas' auspicious phrase, is the *imperative of responsibility*. For a new centre in a small university that is part of an also relatively small international organisation, this may be viewed as a grandiose commitment to an overwhelming task. Yet the work must begin and if not here, where? If not now, when? And if not with us, then with whom?

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BIOGRAPHY



Harold P. Sjursen is a professor of philosophy and the Associate Provost for International Education and Research at the Polytechnic University in Brooklyn, New York, USA. He is the Director of the *Center for Liberal Arts in Engineering Education*, a satellite centre of the UICEE, and

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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*.

**Conference Proceedings of the
9th UICEE Annual Conference on Engineering Education
under the theme: *International Quality in Engineering Education***

edited by Zenon J. Pudlowski

The 9th UICEE Annual Conference on Engineering Education, held under the theme of *International Quality in Engineering Education*, was organised by the UNESCO International Centre for Engineering Education (UICEE) and was staged in Muscat, Sultanate of Oman, between 11 and 15 February 2006, with the Caledonian College of Engineering (CCE) acting as the host and principal co-sponsor.

This volume of Proceedings encompasses a wide selection of various papers submitted to this Conference, which detail important international approaches to engineering education research and development related to the Conference theme, as well as other specific activities.

The 48 published papers from authors representing 21 countries offer a commendable collection that focus on fundamental issues, concepts and the achievements of individual researchers. The papers have been organised into the following groups:

- Opening Addresses
- Keynote Addresses
- Case studies
- Important issues and challenges in engineering education
- Innovation and alternatives in engineering education
- Multimedia and the Internet in engineering education
- Quality issues and improvements in engineering education
- Specific engineering education programmes

It is worthwhile noting that, as well as the international input into the Conference, contributions have come from academics representing the Caledonian College of Engineering (CCE). The diversity of subjects, concepts, ideas and international backgrounds in this volume of Proceedings demonstrate the global nature of UICEE-run Conferences, as well as its relevance within the worldwide affairs regarding engineering and technology education.

Importantly, all of the papers have undergone assessment by independent international peer referees and have been professionally edited in order to ensure the high quality and value of the Proceedings into the future. Consequently, it is anticipated that this volume will become a useful source of information on research and development activities in the dynamic and evolving field of engineering and technology education.

In order to purchase a copy of the Proceedings, a cheque for \$A70 (+ \$A10 for postage within Australia, and \$A20 for overseas postage) should be made payable to Monash University - UICEE, and sent to: Administrative Officer, UICEE, Faculty of Engineering, Monash University, Clayton, Victoria 3800, Australia. Tel: +61 3 990-54977 Fax: +61 3 990-51547

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