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The New Alliance between Engineering and Humanities Educators*

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There is a growing awareness that professional engineers need a substantial acquaintance with a variety of subjects traditionally taught within the humanities. This awareness suggests a need for curriculum reform to offer adequate exposure to the humanities. In this discussion, it is argued that curriculum reform will not properly address the problem. This is for reasons both practical and philosophical. Practically, it is evident that the engineering curriculum is already quite demanding and is in need of expansion in multiple areas beyond the humanities. Philosophically, it is argued that the addition of more humanities courses to the engineering curriculum will not provide the kind of broadened understanding sought. The solution proposed is the creation of formal intellectual alliances between humanists and engineers to foster the reflective discourse needed to impute humanistic concerns into the problem-solving strategies of engineers. It is acknowledged that this approach places a greater demand on scholars in the humanities, but that this is an educational and social imperative.

INTRODUCTION

The argument is often made that engineers need more exposure to the humanities. This position reflects the claim put forth on many fronts that modern, scientific technology poses many questions of a highly value-laden nature that can only be addressed using the methods and insights of the humanities. Engineering educators generally agree with this proposition but ask how additional instruction in the humanities can be introduced to the undergraduate degree programme without weakening the already overloaded engineering curriculum. There is also the question of what instruction in the humanities is appropriate?

The list of authors regarded as essential in Europe and the USA is unlikely to be accepted in other parts of the world. The inclusion of the humanities in the globalisation of engineering education risks the reintroduction of a colonial or imperial mentality unless multicultural norms can be found. A recent study has argued that the history of the World Bank, whose mission was post-war reconstruction and development, shows that infrastructure projects cannot easily be divorced from cultural norms and values [1]. Thus engineering education faces incipient crises on two fronts: the pressure created by rapidly changing technology to include additional topics in the baccalaureate programme *and* the growing requirement for engineers to be able to make responsible cultural, political and social decisions that shape the future of the world.

A simple curricular solution cannot address adequately these profound challenges. Rather, engineering and humanities educators need to form discursive alliances, based on mutual respect, that will enrich understanding and create the basis for meaningful deliberation. The problem is not merely a problem for engineering education, but is a major philosophical, cultural, social, economic and political dilemma in our time. Surely, curriculum change regarding the relation between engineering programmes and the humanities is called for, but it needs to occur within an environment that nurtures fundamental discourse between

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engineers, technologists, scientists and the full range of humanists and social commentators.

ENGINEERING EDUCATION

This discussion begins with a radical proposition. To wit: the efforts to reform engineering education, including those that recommend the addition to, or modification of, the curriculum to include project-based learning, teambuilding and leadership development, global competences, the improvement of communication skills and, perhaps most obviously, the enrichment of the humanities component, are all mistaken. This is not to say that they are not in the right spirit or that they are not authentic attempts to address crucial shortcomings. The problem is simply that they cannot be achieved in a way that will solve the problems that beset engineering education. This claim, however, goes beyond the usual pragmatic considerations associated with curriculum reform. The additional circumstance in this case is that it is difficult on purely conceptual level to state what humanistic knowledge is needed or desirable for engineers or technologists in our time.

Currently, engineering education exhibits two maladies. The first is within the narrowly defined domain of technical or engineering training, and has to do with engineering skills *per se* and with their relationship to science and mathematics. In a sense, this is because engineering itself has become both more technical and less technical. There are many illustrations of this seemingly contradictory phenomenon. More and more engineering projects are extremely scientific and require deep knowledge of a variety of disciplines covering the full spectrum from biology to physics. The representation of the knowledge from these disciplines tends to be highly mathematical as mathematics is the language that permits discourse between biology and physics. But at the same time, much of this is apparently simplified and made available with an impressive degree of operational sophistication, even to those with a minimal grasp of the underlying processes, by means of computer technology. Thus, many very complex processes are masked by pleasing and rather simple computer interfaces. This creates an illusion of competence and one of the unpleasant tasks of engineering education is often to dissuade students of false presumptions of understanding.

This problem is *epistemological*, and strikes at the very heart of what engineering and technology as disciplines are. Neither is science, although science, ie precise and demonstrated knowledge, is increasingly central to engineering and technological practice. Engineering is based upon the utility of specific knowledge although engineering discovery may occur in the absence of such knowledge. Technology is also related to science in the sense that it can often unlock the utility of science. Recent technology has done that with much of biological science, for example. Such unlocking adds a new human dimension to the science and changes what it is in itself. Thus, engineering/technology both uses and creates science. Indeed, it is through engineering that science becomes human science.

Engineers, for the reasons suggested above, perhaps more than ever before, need to be scientists and competent applied mathematicians. This is to say that engineering rests upon complex theoretical grounds, and that innovative engineering research and practice needs to cultivate and care for such grounds. The problem for engineering education is that the demands of rigorous and contemporary science education are simply more than can be fit into an undergraduate engineering programme. Moreover, the mindsets of science and engineering students are frequently inimical, if not, then they share only limited commonalities. Engineering students often express impatience with, and distaste for, their required science courses. This leads to the other side of the dilemma. If engineering students prefer practical, *hands-on* project-oriented, experiential learning while disdaining theory, the fact is that the majority enter engineering school with very little background for this kind of work. It is also increasingly rare to meet students who have had much or any experience tinkering or repairing equipment. Those students who have rebuilt a carburettor or put together a *ham* radio station are few and far between. In part, this is due to technological advancement and the ubiquitous presence of the microchip that makes it incredibly difficult or impossible to figure out how something works by carefully disassembling it and looking. The discovery of mechanical principles that could be achieved simply by taking an alarm clock apart is no longer an option found on every bedside table.

These are dilemmas for engineering education. Students need more science and advanced mathematics in order to prepare for the sophisticated, advanced and innovative engineering work that will shape the future. The rigour and intensity of this kind of study is such that it cannot simply be added to the curriculum. Furthermore, it is not what most engineering students are well prepared to do or desire. On the other hand, what they do desire and what is also essential to engineering, ie *hands-on* experiential project-based learning, is something that most students have almost no background for. So the challenge engineering faculties face, before being asked to improve their

students' communications skills, leadership tendencies and project management acumen, is already nearly overwhelming. Where, short of making the undergraduate degree a five or six-year programme, is humanities education supposed to fit in? It is partially for these reasons that there are now calls to make the MS or MEng degree the first professional degree for engineers.

The realistic answer is that it cannot. From the standpoint of the humanities, it is important to acknowledge this and imagine an honest strategy to address the loss. The adjective *honest* is used mindfully. For the temptation will be, in order to save faculty lines and assuage accrediting agencies, to offer professional courses of instrumental value – perhaps something like technical writing – and claim that such instruction, without doubt valuable, provides all the humanities that engineers really need. If this kind of cosy relationship were to become normative, it would be a dishonest representation of the humanities, and do a great disservice to both the engineering profession and the public at large, evermore in need of engineers whose human perspective is both long and broad.

Thus, the thesis contained in the radical proposition put forth at the outset: the humanities must become a partner, equally powerful and equally determinative, with engineering (and not an ever-diminishing under labourer) mutually engaged in the project of educating the engineer of the future.

A CRISIS IN OUR TIMES

The stage has been reached where universities around the world now aspire to be true to their name and, in the argot of the day, be *comprehensive*. Engineering, once a stepchild banished to the periphery, to sit *next to the stove* so to speak in the *house* of intellect, is now being introduced in the *front parlour* as proof of a university's commitment to the future. Princeton University now showcases its engineering school while New York University laments its decision a quarter of a century ago to abandon its own (although it is currently discussing the possible re-merger with their abandoned engineering school). From the point of view of research or public service or economic growth through government funding and collaboration with industry, there is a powerful motivation for universities to emphasise engineering. These motivations, however, guarantee neither excellence nor contemporaneity for engineering education. Indeed, these motivations, if left to their own purposes, are likely to erode the quality of education.

Some may feel that the idea engineering *education* is something of an oxymoron. Engineers, the argument goes, should be well trained in engineering, science and mathematics as appropriate. Such competent engineers should further be prepared to work closely with representatives from other specialisations in pursuit of wealth and the common good. One could make similar arguments on behalf of legal or medical education as well. In all cases, such arguments are dangerous as they foster the situation where the professionals most instrumental in guarding the well being of individuals and the commonweal are not by virtue of their professions informed about the texture of human value and the history of human tradition. Yet the situation is most emphatic in the case of engineering. Engineers have traditionally been subservient, taking orders as in the military. But in the present, where modern, scientific technology has empowered engineering to make irreversible changes to the natural order, changes that may most profoundly alter the character and quality of life, engineers must at least share in the choice-making processes where their expertise is unknown by anyone else.

Additionally, there is what may be called the paradox of technology. The paradox is that technology seems both to expand and limit human freedom. How is this possible? Technology, whether through mechanical or other means, can alleviate much human labour without loss and generally with a gain in productivity. Thus, technology can produce both leisure and wealth. The consequent increase in both liberates humanity from much of the slave-like effort needed to survive. In this sense, we are freer because we are less obligated to the onerous requirements of self-preservation. However, at the same time, technology turns into a new master as we become more dependent on it, eventually lacking the skills, knowledge and disposition to manage our own lives autonomously. Engineering, as the concrete practice of technology, in fact positions us along this human freedom continuum between empowerment and dependency. The determination of whether this positioning is done with understanding, wisdom and discernment is part of the subject matter of the humanities.

In short, for these reasons, engineers must be humanists in order to exercise their vocation responsibly. But the trends in education, for powerful technical and economic reasons, seem to obviate this necessity. What is the solution?

AFFILIATION, CONFEDERATION, PARTNERSHIP?

Neither addition nor assimilation is possible. The relationship between engineering and the humanities is one that traditionally has not been close, and for the

reasons pointed out, the engineering curriculum cannot add new humanities courses to its already-crowded programme. Nor is it reasonable to propose that engineering courses can take on the additional requirement of teaching humanities (this is a different issue than whether or not the expectations for clear and precise communications can be increased in engineering courses). Also, given the growing technical complexity of engineering, it is not advisable to assimilate engineering into the liberal arts curriculum as another major, along side of physics, for example.

The solution may be based upon a carefully-considered partnership between the humanities and engineering. In this partnership, engineers and humanists each retain their own intellectual identity, their own perspectives and values, pedagogical methods and, of course, their own status and degree of autonomy within the university. Humanists should not emulate engineering teachers nor vice versa. However, these distinctions and boundaries should not imply alienation from each other. While intellectual identity and pedagogical methods are distinct, there remains a field of common ground large enough to permit mutually beneficial rules of engagement.

How can a meaningful, from the multiple standpoints of education, research and public service, discourse between humanities and engineering be created? Is there really a two-culture problem that must be overcome before such discourse is possible or likely? Can engineers and humanists collaborate on crucial world issues that are both technical and value-laden, such as global warming? Is any of this plausible in the context of education?

In order to address this, consider the example of an experimental course, supported by the NSF Gateway coalition of engineering schools, offered jointly by the Polytechnic University and the Cooper Union for the Advancement of Science and Art [2]. The Polytechnic University is the second-oldest private engineering college in the USA, while Cooper Union, established in 1859, is ranked among the nation's oldest and most distinguished institutions of higher learning. Despite the fact that both are urban institutions located in New York City, are of comparable size, and are both old private universities serving similar populations, there are nonetheless, as suggested by their names, deep and profound differences between them. The Polytechnic University, for many years known as Brooklyn Polytechnic Institute or *Brooklyn Poly*, carries the image of a gritty, roll-up-your-sleeves, no-nonsense place training practical and technically competent individuals ready for the industrial workplace. The Cooper Union, on the other hand, is comprised of the School of Architecture, School of Art, a Faculty of Humanities and Social Sciences, as well as the Engineering College, and conveys an image more often associated with men and women of letters than with those involved with industry.

The experimental course enrolled half of its students from the faculty of humanities and social sciences at Cooper and half from the engineering disciplines at Polytechnic. The course similarly was team-taught by faculty from the humanities and engineering. The course was offered on two occasions: the first time under the general heading of *Cities* and the second *Bridges*. In these courses, the engineering faculty dealt with the obvious technical issues while the humanities faculty ranged over a broad spectrum of aesthetic, cultural, historical and value questions. The students worked in teams and the major component of the course was a design project.

The subject matter in both cases (*cities* and *bridges*) was easily integrated across disciplines. Remarkably, the engineering faculty expressed such observations as that their presentations of the structural aspects of bridge design were enhanced and motivated by the students' awareness of aesthetic and cultural issues. The engineering problems, in other words, were placed in a real-world context that students related to. There was no, as might have been feared, adulteration or diminution of the technical content presented to the engineers; engineering and non-engineering students had some alternative assignments to correspond to the differing skill sets they brought to the course.

What was striking about the course had less to do with the ease by which the content could be integrated, but rather with the responses of the students to this type of learning environment. Indeed, it is from these responses that one can learn about the ideal relationship between engineering and the humanities.

At the outset, it was clear that the students from the two groups (humanities students and engineering students) exhibited very different learning styles. For both the engineering and humanities students, these differences made them reluctant to interact with students from the other group. The instructors (who also exhibited distinct and different learning and teaching styles) had anticipated this and, therefore, assigned students to teams that were diverse. Although the dramatically different approaches to learning never changed, this turned out to be an advantage. The difference became the basis for a rich discourse among the student team members that explored the issues inherent in the assigned project from a multiplicity of perspectives and interests greater than would have been likely in more monolithic teams. In short, humanists and engineers had come together to collaborate on

what was essentially an engineering exercise and did so, to their mutual benefit, without each group abandoning their native approach.

To say that the project *was essentially an engineering exercise* of course makes a strong statement about the nature of engineering as a branch of the humanities. Public projects, such as bridges, clearly exemplify the need on the part of engineering for powerful interaction and communication with a wide variety of non-technical points of view. This kind of interaction suggests the model within the academy for the relationship between engineering and the humanities.

In the context of this experimental course, the engineering students learned not particularly academic humanities, but genuine humanities nonetheless. Likewise, the humanists became educated in engineering, although clearly not to the level of a student aspiring to become a practising engineer. Such courses may exemplify the best model for the teaching of humanities to engineers and, by extension, suggest the most appropriate model for the best relationship between engineering and humanities faculties. It is only when the relationship between the two faculties is healthy and stable that we can hope for collaborative education.

This point is vital. What is called for is not so much a revision or expansion of what constitute engineering, but rather a profound reorientation of what is called the humanities. A legitimate specialisation within humanistic studies is technology. Humanist scholars who focus on technology have an intellectual responsibility to understand it, so to speak, from the inside and not only from the perspective of those who live (as we all do) in the technologically constituted *lifeworld*. An insider's understanding of technology is what engineers have. The imperative is for humanist scholars to learn how to view the *lifeworld* from the perspective of engineering. Only then can a meaningful dialogue be obtained between technologists/ engineers and humanists.

A recent conference was devoted to a consideration of the new role for the humanities in Asia [3]. The specific emphasis was *the fine line* between the humanities and sciences. A number of very interesting issues emerged. The first had to do with the fissures existing within the community of humanists. These fault lines generally followed the contours established by the world's universal systems, be they religious or secular. Is there any true way to reconcile the proclamations of, say, Christianity and Confucianism? A second set of debates focused on the validity of the variety of methods used by the human sciences (a term still understood in Europe). One easily gained the sense that intellectual collaboration was likely to be easier between any of the humanities and the natural sciences than it is within the family of humanists. A presentation advocating the collaboration of humanists and engineers was well received, although perhaps only because of its surprising novelty. In fact, very few academic humanists have ever seriously considered collaboration or shared discourse with engineers. The opposite is also no doubt the case. However, as evidenced from this conference, there is, at least from the humanistic side, an openness towards this approach and a reservoir of good will deep enough to sustain it into the future. How might cooperation between academic humanists and engineering educators be promoted? Since curricular *reform* has been ruled out, at least in the near term, the options left are all forms of institutional collaboration. Yet to encourage the free exploration of ideas and to minimise the possibly detrimental effects of bureaucratic control, these collaborative institutions should not be the agencies of university administrations. What form of institutional collaboration is desirable?

A CENTRE FOR LIBERAL ARTS IN ENGINEERING EDUCATION

The Polytechnic University hosts the newly-established *Centre for the Liberal Arts in Engineering Education*, a satellite centre of the UNESCO International Centre for Engineering Education (UICEE). The mission of this satellite centre includes the creation of a network that will proliferate discussion between academic humanists and engineering educators, together with representatives of industry, government and non-government organisations. The Centre will join the international Consortium of Humanities Centers and Institutes (CHCI), thus opening channels of communication between engineering educators and humanists globally that have not existed previously [4]. It is also likely that this UICEE satellite centre will be represented in an industry-university research centre.

It may be the case that engineers have a more acute appreciation for the importance of the humanities than humanists do for engineering. In fact, academic humanists tend to locate engineering education beyond the horizon of their interest or concern. For this reason, it is necessary for engineering educators to take the initiative and reach out to develop formal *intellectually-based* institutional relationships.

Engineers have not traditionally been seen as residents of the house of intellect. Wittgenstein began as an aeronautical engineer and Spinoza was a lens grinder, but their fame derived from investigations far afield from such training. If engineering educators are going to reach out to their colleagues in the humanities,

what will be the reason for their overture? When C.P. Snow discussed *the two cultures*, he noted a certain condescension on the part of university humanists directed, for example, towards the possibly naïve readings of literary texts undertaken by members of the scientific community [5]. One recognises a form of this attitude persisting today as when, in a typical instance, a physicist expresses his faith and offers an interpretation of the Christian Bible from the point of view of a scientist only to be told by literary deconstructionists that the reading is hopelessly uninformed.

As noted in the example of the experimental course discussed above, a successful exchange does not happen when participants leave the domain of their own expertise. When discussing bridges, the engineering and liberal arts students discovered that they had, each from their own perspectives, interesting and valuable insights to offer their teammates from other disciplines. Therefore, when engineers address humanists, they should articulate their own expertise on issues of common human concern. In so doing, they should not use the jargon of engineering practice and in fact, unfortunately, they may need to simplify technical problems just in order gain a hearing. But since the great majority of engineering projects address fundamental human concerns on what engineers should do, indeed for the sake of the future, they must be understood as profound issues for the good of humanity itself. One can say – quite legitimately – that engineering is a humanistic discipline for the very reason that it is engineers who create, design, implement and operate (CDIO) the *human* world. What engineers do is what makes possible human freedom and liberty, allows us to survive in nature with sufficient leisure to pursue the life of the mind, and grants us the security needed to raise families and make choices based on preference.

The persistence of the *two cultures* within higher education especially is no longer tolerable. It is truly an imperative for humanist scholars to engage in substantive and discursive dialogue with the community of technologist/engineers.

When we reflect on the crucial issues facing the world, such as global warming, adequate housing, pandemic disease, energy, mass transportation, communication, information, education and so on, we realise that everyone requires engineering. And they require engineering not simply because they have major technological aspects, but also because they can only be approached effectively by that kind of practice that is ultimately identified with engineering. It is engineering practice that makes changes and sustains the world.

Of course, only engineering in the narrow sense does not provide the basis for good judgements and responsible solutions. Nor in the environment of geopolitics and global economics does engineering alone have sufficient means to implement its solutions. For engineering to do the work of engineering, it must be a collaborative partner with the other human sciences.

Since all the crucial issues facing humanity are global, the movement to establish meaningful discourse between engineers and humanists (and economists, lawyers and politicians) must likewise be international and global. The problems and challenges facing the world do not know political boundaries. It is on this level that engineering can make a great contribution. The skills of engineering cross borders easily and much of what engineers are the acknowledged stewards already has international standards. Good engineering practice has not been subordinated to political interests to the same degree as other disciplines (such as economics or law). Even natural science has been politicised to an extent greater than engineering. This is not to say that engineering is free from political influence, on the contrary, but there is a greater possibility for an apolitical engineering than is the case in many other endeavours. As a discipline and practice, engineering has a better opportunity to achieve worldwide acceptance than many others. As engineering makes its overtures to the humanities, it must do so with a global consciousness (thus helping repair some of the cracks noted in debates among humanists), mindful of the need to establish standards respectful of human interests and not simply responsive to economic opportunities.

The burden to form this alliance does not rest solely on the shoulders of engineers. Although it is true that the majority of humanists show little interest in engineering questions, there are important exceptions. However, some of the most prominent, for example the influential thinkers Martin Heidegger and Jaques Ellul, come to mind, who argued that technology was a pernicious and nearly totally determining influence on the quality of human existence [6]. According to them, there are highly problematic, undesirable and inevitable social, political and economic consequences of technology. They do see technology in the service of the good life, but anticipate a future where we are doomed to lives organised and priorities set by the demands of machines and systems.

Yet other influential humanists and philosophers have responded to this type of techno-pessimism with powerful analyses that appreciate both the potential danger *and* redemptive power of modern scientific technology. Two such thinkers whose work guides the research at the *Centre for Liberal Arts in Engineering Education* are Hans Jonas and Carl Mitcham. The

latter has written an interesting book that relates engineering and philosophy: *Thinking through Technology: The Path between Engineering and Philosophy* [7]. Jonas, who was one of Heidegger's most famous students and who broke dramatically with him, has articulated the ethical challenges posed by technology in his very influential (in Germany and elsewhere in Europe) book, *The Imperative of Responsibility: In Search of an Ethics for the Technological Age* [8]. These two books can help shape the intellectual agenda for collaboration between engineering educators and academic humanists.

The *Centre for Liberal Arts in Engineering Education* will endeavour to establish a dialogue between engineering educators and academic humanists; it will affiliate with organisations in order to create networks and raise funds to create scholarships to support the PhD education of *engineer humanists*. As a sub-centre of the UICEE, organised and operated by faculty, the Centre is global in outlook and will work closely with all of the Partner institutions of the UICEE network. The Centre will also collaborate closely with the Polytechnic University Institute for Global Alliances for Technology Education (InGATE) to promote international student and faculty exchange in technology and engineering education and research. The Centre has plans to maintain a Web site and, in the future, publish the results of its sponsored research.

CONCLUSIONS

This discussion has been wide-ranging, but specific conclusions may be drawn, as follows:

- The required curriculum in engineering education is expanding beyond the point where programme revision can absorb all of the new demands;
- Especially given the increased technical and scientific components needed for quality engineering education, the expectation that the curriculum can accommodate new or even sustain the present proportion of humanities courses is unrealistic;
- Much of what is needed in engineering education can be provided through new modalities of instruction. Experimental courses, such as the *Bridges* course described above, put engineering and humanities *problemata* on the same level and foster cross-disciplinary approaches to solving them;
- This situation creates a crisis in education as a meaningful synthesis of an informed humanistic outlook and engineering training is essential to address the crucial issues of our times;
- Collaboration on a high order intellectual basis between engineering educators and academic humanists will help create a new discourse that will improve the quality of education on all levels;
- The conflict of value systems in a pluralistic world has led to an exacerbated polarisation and politicisation on issues of vital concern to humanity. Engineering may be able to help mediate among contending interest groups;
- Engineering practice has succeeded in the creation of internationally-accepted standards to an extent greater than in many other disciplines, putting engineering in an advantageous position for the global exchange of ideas;
- The *Centre for the Liberal Arts in Engineering Education* will, through research, dialogue and global alliances, address these crucial issues.

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4. Established in 1988, the Consortium of Humanities Centers and Institutes (CHCI) serves as a site for the discussion of issues germane to the fostering of cross-disciplinary activity and as a network for the circulation of information and the sharing of resources. It has a membership of over 150 centres and institutes that are remarkably diverse in size and scope, and are located in the USA, Australia, Canada, Finland, Taiwan, Ireland, Sri Lanka, the UK and other countries.
5. *The Two Cultures* includes Lord Snow's original lecture and follow up written five years later. His view suggests a dereliction of responsibility on the part of humanists.
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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*. Prof. Sjursen is presently Chairman of the UICEE Academic Advisory Committee (AAC).