Sensitizing Engineers

A Brief Study of the Role of Ethics in Engineering Education

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Abstract—**This paper focuses on the essentiality of incorporating ethics as a course in engineering education. It claims that an amalgamation of ethical awareness and engineering skills can enable the future engineers to strengthen the relation between technology and society.**

Keywords—engineering; philosophy; ethics; society.

I. INTRODUCTION

Ethical awareness is doubtlessly an essential requirement in engineers and this fact rarely evokes a disagreement. We tend to feel that being ethical is good, as it sounds good and makes us look good in the eyes of others, thereby, proving that we all want to fit into our individual notion of the 'good', which, at the same time, should coincide with the sense of morality sustained by our social climate. If that concept of good is challenged, our belief system, which is its rootage, is challenged as well. However, did we consider that the idea of goodness varies from person to person? In that case, some questions arise. If our beliefs are open to scrutiny and can afford to have exceptions, are they fundamental and absolute? Where do our ethics come from? Is it from religion or family? From culture or from nature? Answers to these questions, unlike those to empirical questions which can be concretely found if the resources are known to us, are hard to find. To define 'ethics', one may say, "it is the branch of study dealing with what is the proper course of action for [the hu]man" [1]. As contested earlier, the sense of propriety is bound to vary from person to person. Hence we can say that we all have our own set of ethics which is socially, geographically, culturally, religiously and professionally conditioned. Students who have been oriented into the study of engineering require a sound sense of ethics to make professional decisions in future. In this age of artificial intelligence, where human beings are successful in creating computers as well as computer softwares capable of intelligent behaviour, it is equally essential that they are capable of making appropriate professional decisions as engineering has a direct relation to the society's welfare. In this enterprise a mandatory requirement is the individual's ability to "think". Psychologist B. F. Skinner famously said: "The real problem is not whether machines think but whether men do." The concern raised by Skinner is all the more applicable in the case of the present generation of students who are habituated to decide upon things instantly, taking less efforts in reasoning out what are the other available options. Ethics provide students with a vantage point from where they can have an objective approach towards any problem, which is also the first step of problem-solving. "...the essential prerequisite to solving any problem is to define exactly what the problem is, and the engineering approach truly emphasizes this point. The need to propose possible solutions and evaluate them requires the formulation of a 'thought' model or analogy based on the particular circumstances and a logical process of evaluation. Again, the fact that there is no unique solution to an engineering problem, but only a compromise solution chosen from a number of possible solutions, is another essential concept in solving real-world problems and leads directly to the need for decision making processes" [2]. In this quote from Professor Douglas Lewin's article named "Engineering Philosophy –The Third Culture?" the author tries to exonerate engineering from the constricted definition which delimits it to be a profession that aims at merely designing and manufacturing artifacts. He demands for the recognition of an engineering philosophy that shall broaden the purview of the profession and uphold its creativity in problem-solving within a perplexed environment. While emphasizing the necessity of an engineering philosophy, Lewis opines that doing so shall liberate engineering education through a confluence of the arts and sciences.

Engineering philosophy, which concerns itself with the philosophical issues that are applicable to engineering, also includes ethical concerns. Hence prediction related to an artifact is not only about its proper functioning but also regarding its social usability and value. However, ethics is better understood if one learns about the different philosophical approaches towards decision-making that has been the prerogative of philosophers so far. The realisation that our point of view is not the one and only way to interpret something, makes us respect other's perceptions.

II. ETHICS AS A BRANCH OF PHILOSOPHY

Unfortunately, an average human mind grossly misconstrues the word "philosophy". There is a popular tendency to correlate it with "something" that is otherworldly,impractical if not unexplanable. That philosophy shares an integrated relationship with each and every branch of knowledge thus gets a clean miss. The following words of Philosopher Simon Blackburn might help us to identify the practicality of philosophy as a body of knowledge as well as the necessity of engineering education to collaborate with it. "I would prefer to introduce myself as doing conceptual engineering. For just as

the engineer studies the structure of material things, so the philosopher studies the structure of thought. Understanding the structure involves seeing how parts function and how they interconnect. It means knowing what would happen for better or worse if changes were made. This is what we aim at when we investigate the structures that shape our view of the world. Our concepts or ideas form the mental housing in which we live. We may end up proud of the structures we have built. Or we may believe that they need dismantling and starting afresh. But first, we have to know what they are" [3]. To identify the frameworks which shape our worldview, primarily we need to understand that our beliefs are not "natural" but socio-cultural constructs. One's notion of right and wrong is, therefore, not bound to coincide with that of someone else. As Alain De Botton says:"The philosopher does not only help us to conceive that others may be wrong, he offers us a simple method by which we can ourselves determine what is right. Few philosophers have had a more minimal sense of what is needed to begin a thinking life" [4]. Philosophy thus turns out to be the passage to arrive on ethical ideas through a series of logical reasoning. In the following paragraph, we shall have a brief look at some of the common philosophical ideas that have been popular since ages.

Jeremy Bentham and John Stuart Mill introduced the concept of utilitarianism which claims that, if an action benefits a large number of people, the action is right, turfing out the number of people who suffered as they are less in number. Morality in this case is completely consequential. On the other hand, German philosopher Immanuel Kant propounded the philosophy that an action is morally worthy only if the doer has a noble intention. In Kantian philosophy of morality, a correct action can be morally worthless if one has an unreasonable purpose behind it. Classical philosopher Aristotle opines that justice is giving people what they deserve. This theory in turn, calls forth the question: who decides what a person deserves and how? On the other hand, contemporary philosopher John Rawls thinks that justice is possible only if our basic liberties are decided by a citizenry which is temporarily oblivious of its social, ethnic, cultural and economic identity since, under such circumstances, there would be lesser chances of biasness. These were just a few of the various other philosophical approaches towards morality that have been proposed by eminent philosophers. A philosophical approach towards any body of knowledge initiates the functioning of the inquisitive faculty of the mind which does not accept opinions as facts without reason and justification. Philosophy increases our objectivity towards the subject under concern and therefore gives us a number of slants to perceive the same situation. However, the ethics which we chose for ourselves after reading the subject through different lenses is a matter of individual subjectivity.

Subsequently, ethics can be considered as the more practical side of philosophy. "It can in turn be divided into the general study of goodness, the general study of right action, applied ethics, meta-ethics, moral psychology, and the metaphysics of moral responsibility" [5]. Applied ethics deserves a special mention as it reveals the underlying philosophical ideas behind our day-to-day phenomena at work in particular and in our surroundings in general.

III. ETHICS AND ENGINEERING EDUCATION

The common or rather primitive view of the pattern in which engineers usually work, is the "received view" according to which, engineers are mere participants in enormous organizations where decision-making is the privilege of managers, thus leaving the engineer with minimum authority in taking decisions. "Managers choose what to do, divide work into small jobs, and assign each job to one engineer or small group. Communication between engineers is kept to a minimum to assure management control. An engineer may need permission from his boss even to discuss a project with an engineer in another department or working group. Engineers identify options, test them, and report the results to managers. Managers combine these reports with business information they alone have. Managers decide. Engineers merely advise" [6]. Under such circumstances, the Engineer needs to decide, say, when to blow the whistle or whether to blow it at all. And to do so, the engineer needs to consider her/his area of work as a rational undertaking in order to locate the ethically objectionable issues within it. Taking the right decision under such circumstances becomes crucial because the consequence of such decision-making might have a panoptic effect on the organization as well as on the society. A brief discussion on the *Challenger* disaster might explain the significance of ethical decision–making in the engineering profession. It shall also delineate the horrid consequence that can follow when ethics go wrong.

The space shuttle *Challenger* disaster has, by now, become a classic case study to discuss matters such as whistleblowing, organizational work culture and social security concerns. It also exposes the threats of erroneous organizational practices such as 'groupthink' and 'go fever' and shows the dire consequences of overruling the engineer's advice while making technological decisions. The engineer Roger Boisjoly, who had advised against launching the shuttle in the cold weather, was ignored by the Morton-Thiokol management. This overruling makes a case of unethical decision-making on the part of the management body. In his essay "Technical Decisions: Time to Rethink the Engineer's Responsibility" Michael Davis expresses the views of Rosalind Williams, who is a Historian of Technology at MIT, on the *Challenger* Disaster. According to her observations, "…the Challenger disaster is not a case in which mere managers overruled engineers. Those doing the overruling, three of Thiokol's vice-presidents, all had degrees in engineering. Mason had a bachelor's in aeronautical engineering; Lund, a bachelor's in mechanical engineering. Though Kilminster's bachelors was in math, not engineering, he had a masters in mechanical engineering. The *Challenger* is a case of engineers with management responsibility ignoring the advice of other engineers, their technical staff, not of MBAs run amok." One of the other important reasons behind such nonchalance towards engineers is the pressure that customer-oriented companies create on their management bodies, which, in turn transfer the same to the engineers working under them, thereby curbing the engineer's authority in decision-making, unlike the work culture of engineering-

oriented companies where managers and engineers do reject customer requests which, if kept, might challenge the company's ethics.

Incidentally, just a year before the *Challenger* disaster, the Accreditation Board for Engineering and Technology (ABET) in the United States decided that an understanding of the ethical features of engineering should be mandatory for all students pursuing engineering programs. The interpolation of ethical awareness within engineering programs in ABET might have initially appeared to be a fad as applied ethics, especially in the field of medicine, was gathering a lot of attention during the 1970s. However, the coincidental occurrence of the challenger disaster just a year after this modification by ABET established the essentiality of ethical standards in the engineering domain. "The ABET 2000 requirements are more specific, requiring that graduates of engineering programs have an understanding of the impact of engineering in a global and societal context, as well as an understanding of contemporary issues related to engineering. ABET 2000 also requires that students have a "major design experience" that includes ethical factors in addition to economic, environmental, social and political factors" [7].It is of the utmost importance for the engineer to know that her/his work does not stand in isolation for its own sake. Therefore, while approaching any engineering project the engineer has to keep in mind the effect as well as the utility of the project on the society. Here I would like to discuss another kind of ethical awareness that has become an essential requirement of almost all corporate houses, namely: Corporate Social Responsibility (CSR).

Today, the rapid advancement in business economy can definitely be attributed to the extreme technological sophistication. We all are aware of the extent to which technology is being used to meet company targets and raise their global standards. Under such circumstances, it becomes essential that companies not only enjoy the yields of their business profits but also stand responsible for the social and economic effects their activities have on the society. A corporation's social responsibility shows the way/s in which it pays back to the society. This is relevant to engineering students as recruitments of engineers in customer-oriented companies have increased in recent times. So, even if engineering students go for startups, which is highly in trend right now, an awareness of CSR would help them stand out in the crowd.

IV. ETHICS AS A TOOL IN ENHANCING ENGINEERING EDUCATION

Teaching ethics in a classroom filled with engineering students can be a tough challenge, as 'ethics' has an apparent simplicity which is actually deceptive. It appears to be something that students feel that they already know. Hence, the facilitator needs to treat ethics as a tool to enhance the student's overall teaching-learning experience. They need to realise that whereas different disciplines make us see and interpret the world through different lenses, philosophy in general and ethics in particular brings those very lenses under examination. Briefing them on some of the classical philosophical frameworks which examine concepts like truth,

justice, liberty and so on, broadens their outlook towards life. Society grooms us to accept long-established norms unquestioningly. It is philosophy that questions the base of those norms and compels us to doubt their authority. Socrates' method of examining common sense could be one of the ways of doing so. Socrates wondered whether the notion of 'popularity' made any sense as we all commit the mistake of linking popularity with correctness.

Interpreting twenty-first-century social, cultural and economic phenomena in terms of classical philosophies can be a fascinating activity in class. For example, a Kantian analysis of shopping in malls or a libertarian analysis of a cricket match or a utilitarian analysis of whistleblowing would increase the inquisitiveness of the students and deepen their observations.

While teaching this course to higher semester engineering students, it is often noticed that some students cannot relate to general ethical concerns or are nonchalant towards them. The reason behind this could be the fact that they either cannot locate the problem, or else they do not know how to generate an opinion. Such students can be asked to comment on ethically questionable issues from their day to day practices such as offline and online gaming, advertisements, use of expensive gadgets like smart phones, restrictions as well as legal enforcement of morality. Consequently, students themselves come up with the various ethical issues they face in something as commonplace as gaming. Exposure to violence, addiction, encouraging restlessness are some of the unethical by-products of the gaming industry which were pointed out by the third semester civil engineering students. When asked to opine on such relevant issues, students share their points of view with each other and the entire class benefits from it. These discussions help the students to break the ice as most of them, to their own surprise, come up with an opinion upon the issues.

When students are asked to present on practical issues under applied ethics, they use the different theoretical frameworks of moral philosophy and try to analyse the problem in their own way. For example, in the previous semester, fourth semeseter electrical engineering students were supposed to present on various kinds of discrimination and their effects. The group comprised of seven members. The class had expected a conventional, formal presentation. However, the group came up with a beautiful skit which acted out the vices of discrimination. When some of the students in the audience made fun of the unconventional presentation through boos and catcalls, the performing group intelligently contextualised that behaviour to their presentation, calling it the mob-culture, which criticises anything that is different, thereby escalating the upshots of discrimination on the basis of race, caste or ethnicity.

Hence we can say that making the students realise the presence of ethical issues in the current affairs or even in their daily practices creates a greater awareness among them. Through the presentations and theatrical performances students have a dynamic teaching-learning experience in the classroom.

V. CONCLUSION

As far as the requirement of teaching ethics to engineering students is concerned, one might often find it insignificant, as an ethical malfunction like the *Challenger* disaster occurs rarely. Moreover, any technological enterprise, even if it is as commonplace as a domestic flight, carries a risk of going astray. Which means, that if we enjoy the success of technology, we must also be ready to bear the brunt of its failure. When technological errors are inadvertent in nature, engineers have least culpability as no one can be actually held responsible for it. But when technological errors are a result of unethical decisions on the part of engineers, they are the ones to be held responsible for the loss. We should realise that technological disasters damage the society's faith in technology as well. Along with their technological capabilities, engineers are mandatorily required to culture their ethical awareness to retain the society's reliance on science and technology. Ethical awareness makes the engineers conscious of their roles outside their office and they realise the power they have in transforming lives through innovation and design. In this article, we have tried to show the ways in which ethics as a course helps in the overall development of our engineering students and how it can act as a tool to sensitise them towards their obligations towards the society. In so doing, we have argued in favour of a reconciliation between the two historical belligerents: humanities and science. Hence we found Theo Jansen's words, that, "The walls between art and engineering exist only in our minds" extremely pertinent.

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