Ethical Issues Facing Engineers and their Profession

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ABSTRACT: *Frequently, and in many different countries, the engineering professionals are criticized for a number of occurrences that took place and which adversely affected people or the environment. Everything that engineers do affects the society and its development and, occasionally, the consequences of these actions are not fully thought out, not anticipated, or not fully understood, but the results are undesirable just the same. In order to meet the challenges of the time engineers must be properly prepared to face the moral, legal and ethical ramifications of their actions. Thus, to meet their responsibilities to society at large and the global community, engineers must be equipped with the knowledge and ability to fully and cogently explain their actions as well as the methods to be used to implement their decisions. This is particularly important in presenting the engineering alternatives that are considered so that informed conclusions can be drawn and appropriate decisions drawn involving different segments of the society. Educating young engineers about to enter the practice of their chosen profession how to help arrive to the compromises to be implemented becomes one of the paramount items of contemporary engineering education. Case studies detailing occurrences and accidents that took place, explanations of recalls implemented by major manufacturers or evolving legislation engendered by events that triggered introduction of these, are examined in detail in preparing engineers to face this contemporary challenge. Ethical theories are presented as are codes of ethics that different professional societies developed and which provide the structure for this paradigm of professional practice. Solving conflict of interest problems that are encountered in practice help explain the approaches to risk, safety and reduction of accidents.*

1   INTRODUCTION

We celebrate the engineering profession because of the great good that it can produce in solving a myriad of pressing problems affecting the happiness and well-being of society. The technological advances which engineers have contributed to generating advances that have significantly improved our quality of life in ways so numerous that we cannot imagine the modern world without them. Engineering is the profession that provides the technical solutions necessary for contributing to a better and more efficient world. It takes what we know and applies it to solving society's problems. And while the education of engineers focuses almost exclusively on developing the technical capacities of aspiring engineers for solving a host of technical problems facing society, it has not also sufficiently advanced the moral character of those who call themselves "Engineers." In this paper we wish to call attention to the important contribution that engineering education can make to enhance the ethical sensibilities of engineers. Such efforts are crucial to ensuring that the trust we invest in engineering as a profession and critical to the future well-being of society and the profession is justified.

What is ethics?

"Ethics" or "morals"—we regularly use these two terms interchangeably—means those habits or customs that are standards of good conduct or character. To be ethical is to do the right thing; to consider the well-being of others as equal to your own; and to act in ways that aim to maximize the good. To be ethical is to be righteous, in the sense that our conduct and character are grounded on principle and a commitment to doing our duty regardless of narrow self-interest. To be moral is to be fair and considerate of others, particularly to show them the respect we ourselves demand that acknowledges rights to life, liberty and property. Ethics is a discipline we freely embrace that regulates our baser instincts so as to promote a harmonious community and thereby reduce conflict and disorder. We expect others to order their behavior so as to not harm things of value and being ethical is the principal method for protecting

and sustaining those values. In short, the choices we make and the habits we maintain as a result should be ethical, for such a life is a good life, one that enhances our happiness and promotes the good of society.

Unfortunately, too often people consider ethics in a negative light; they seem to think that doing what's right is an unnecessary limitation of their freedom, requiring them to do things they don't want to do. In some way this is true but not totally true. While submitting to the discipline of an ethical life means we will not choose to do certain things that may be harmful to others or undermine our principles, such a discipline does not inherently imply either a restriction or a reduction of our personal freedom. Being ethical involves a free choice that commits one to doing what's right and because it is freely chosen it is misleading to think our freedom is in any way restricted or compromised. Nor is it the case that being an ethical individual reduces our freedom; in fact, like the rules of the highway, ethical rules bring order to our experience and enhance our ability to achieve our ends. When we pass each other on the highway, I know what to expect from you as you approach me which enables us to pass each other safely and efficiently. Simply stated, if we all observe the rules of the road this is the best way to avoid a collision, thereby insuring our safety and protecting our property as well as enabling each of us to reach our destinations effectively. It is in our interest to be ethical just as it is in our interest to observe the rules of the road.

Likewise, ethics is not simply an activity that enables us to hold people accountable for their behavior or, to put it bluntly, to play "the blame game." While there is an expectation that an ethical person *be* accountable for their behavior, accountability and the assignment of blame for unethical behavior are not the main purpose of ethics. This negative concept of ethics unfortunately predominates in the public's mind, especially reinforced by the media's hypercritical stance towards those who violate ethical norms; it likes to point the finger of blame and shout "You're immoral; that's unethical !" No doubt we censure behavior that contradicts social mores because to do otherwise exposes us all to harm with the consequent threat to our human rights, just as we express our outrage whenever another driver veers over to the wrong side of the road and endangers our life and property.

But this only a part of what ethics is about. There is a more positive and enriching concept of ethics derived from ancient Greek philosophy that suggests that being ethical involves a vision of an orderly and harmonious community, freely choosing to regulate their behavior in accordance with standards that promote the common good and the rights of others. Ethics, in this positive sense, involves a vision of the good life and a harmonious community wherein each of us can live life to our fullest potential. It is a vision of an orderly society where each person is entitled to freely pursue their goals and desires, so long as doing so does no harm to others. We all have an interest in avoiding harm and the moral point of view is precisely that stance in which we commit ourselves to doing what's right, of striving to be good, and dedicating ourselves to live excellently. Ethics is the practice of being the best we can be, where pursuing excellence is our goal. This is the positive concept of ethics that has been obscured by the negative view that too often predominates when issues of ethics are discussed. To be ethical is to try to do the best we possibly can simply because there is no other better reason for doing anything except to do it well. An ethical individual is inspired by a vision of excellence, and being ethical and adopting the moral points of view define the essence of a good and happy life.

Can ethics be taught?

Given this enriched view of ethics, many have wondered: Can ethics be taught? There can be no doubt but the answer is certainly yes! Each generation recognizes the need to prepare the next one for the responsibilities it must assume in protecting critical human values, in maintaining order and in reducing conflict. We cannot idly stand by and watch as undisciplined individuals who have no regard for the welfare or interests of others act recklessly, destroying that which society values and has built with so much labor. Thus we must prepare each generation to assume the mantle of responsibility that is implicit in being ethical. As Isaac Newton is oft-quoted as saying "If I have achieved greatness it's because I have stood on the shoulders of giants" The issue is not whether ethics can be taught but more importantly what is the method that will best result in teaching the young what they need to know that ensures they will be ethical and act morally. That is the real issue.

In the professions, especially in engineering, preparing aspiring professionals to assume the mantle of responsibility that is central to professional ethics is crucial. Without training in professional ethics society cannot be expected to trust those who act as professionals will use their expertise and power they

possess for the welfare of society. Since we cannot resolve many of our difficulties without professional assistance we are at the mercy of those who possess esoteric knowledge because we are vulnerable to its abuse. We need assurance that professionals will not take advantage of their unique expertise and power to cause harm to things we value or undermine significant societal interests. Thus the teaching of professional ethics is a critical part of the curriculum we ignore at our own risk. Put more strongly, teaching professional ethics may be equally important as the technical competence we instill in our students, as recent scandals of the unethical activities of a wide variety of professionals have so clearly demonstrated.

It is axiomatic that ethical behavior is mandatory in all professions but it is of particular importance in engineering because safety of many people and that of the environment depend on the quality of the design that engineers render. This by itself, in addition to the concern for the value of the property that can suffer destruction and/or damage places a heavy responsibility on engineers.

High visibility cases provide simultaneously tragic and excellent tools for teaching engineering ethics.The list of cases to study is long: The Pinto case that clearly indicated the callousness of the corporation in willingness to sacrifice human life for increased profit, the walkway case at the Hyatt Regency hotel in Kansas City that killed many and injured many more, the explosion of the Space Shuttle Challenger, the Bart case in San Francisco, the DC-10 aircraft case in Paris that killed 346 people, the Bhopal case that killed and poisoned many, the most recent case of the Columbia shuttle that killed the crew of astronauts, numerous.environmental disasters of the Exxon Valdez type and many product liability cases which could have been prevented had the proper engineering scrutiny been in place. These and many other cases amply demonstrate the need to infuse heightened awareness of ethical issues into the education of engineering professionals and to analyze how these could have been avoided had ethical engineering due processes been engaged.

Engineering ethics is a part of professional ethics namely the study of moral values and issues in the professions. Professional organizations such as IEEE, ASCE, ASME, NSPE and many other ones have addressed the complexity of moral issues in their fields by developing codes of ethics. These codes delineate the importance that the profession attributes to ethical behavior but they do not encompass the full domain of professional engineering ethics. There is much more that needs to be engaged.

In his memoirs Herbert Hoover, the only true engineer who was the president of the US compares engineers with other professionals:

"His acts, step by step, are in hard substance. He cannot bury his mistakes
In the graves like the doctors. He cannot argue them into thin air or blame
The judge like the lawyers. He cannot, like the architects, cover his failures
With trees and vines. He cannot, like the politicians, screen his shortcomings
by blaming his opponents and hope that the people will forget. The engineer
simply cannot deny that he did it. If his works do not work, he is damned."

The importance of this responsibility has been readily acknowledged by the professional societies that oversee the activities and training of new entrants to the engineering profession and which are tied to the accreditation process. A strong impetus towards study of ethics issues originated from the ABET 2000 Criteria for accreditation as there is an outcome requirement of "understanding of professional and ethical responsibility". Accreditation Board for Engineering and Technology is the principal accreditation agency attesting as to the quality of the engineering programs in the USA. Criterion 3(f) states that "Engineering programs must demonstrate that their graduates have an understanding of professional and ethical responsibility". It should be noted that this criterion requires and "understanding of" rather than, as it is the case with most other criteria, that require an "ability to". This alleviates the requirement being actually demonstrable yet it is still the goal of engineering educator to imbue the students with solid background of a road map for ethical and professional behavior and ability to navigate the complexities of the modern world.

One way of introducing ethical issues to engineers is through case studies. This method frequently illustrates some issues but it has both strengths and weaknesses. The strength of this approach is that usually a one dimensional case may be explained and ethical dilemmas illustrated. However, real life

seldom presents issues in a one-dimensional context. More often than not, there are varieties of parameters that enter the fray hence the totality of the issues does not enter the considerations. Simplistic situations lead to simplistic solutions. The more difficult issue is perceiving the moral dilemmas and determining the rules and principles to guide the engineer's actions. The responsibility to perform the "right" decision is not always quite clear as are the possible consequences for the career of the engineer.

History of engineering should be a major topic for the introduction of the coverage of the subject matter. Engineering as a profession must be presented to the students. A key concept is that one of the "professional responsibility' that represents moral responsibility based on the engineer's professional training and specialized knowledge. In their book Martin and Schinzinger note that the goal of responsible engineers is "the creation of useful and safe technological products".

ABET criterion 3(h) states that "Engineering programs must demonstrate that their graduates have the broad education necessary to understand the impact of engineering solutions in a global and societal context." This criterion clearly emphasizes the role attributed to understanding not only of the correct choices made by engineering professional but also the importance of right choices made by societies where these engineers practice their skills. Obviously there will be variations in interpreting the choices deemed correct in different cultures but it is clear that the responsibilities are broad and that the decisions may have to change as the technology and societies evolve.

ABET has correctly insisted that engineers through their professional training assume more responsibility for the society they serve. In the criterion 4 the requirement stipulates that "… a major design experience … that includes most of the following considerations: economic, environmental, sustainability, manufacturability, *ethical*, health and safety, social, and political". This criterion mandates that students design effort present them with situations in which they have to make ethical decisions and choices that affect the outcomes. Students are to be faced with situations to consider their actions and the consequences of those as well as provided with choices which affect the society with respect to safety, environmental consequences, ability to rationally explain the choices made with respect to different decisions, indicate that they anticipated possibilities of failures of given hardware and/or software and the consequences of these not excluding liability for these, and the ability to cogently explain the genesis of the design, fabrication methods, maintenance and operations of the product in a regional and global context.

Engineering students are interested in ethical issues as was demonstrated with a high level of questions every single time the authors presented ethics in an engineering context as well as product liability issues.

All engineering codes of ethics give a very prominent place to safety ,stating that engineers must hold paramount the safety, health and welfare of the public. Of course, there is an implicit recognition that every design, every product developed by humans carries a certain degree of risk with it. And the relationship between risk and safety is an obvious one. If designs, products, techniques and materials used are in some manner unsafe they expose humans and the environment to undue risk. Engineers are the people who are responsible for the safety of the general public, they are responsible for making engineering decisions consistent with the safety, health and welfare and these decisions must be made in terms of accepted engineering approaches, they must conform to codes and standards and approved practices. Engineers are to be held responsible for disclosing anything that would subject the public or environment to dangers. In order to perform their functions properly engineers must maintain and improve their competency and engage in continuous learning. Furthermore, engineers must practice their profession only in the areas in which they posses the requisite knowledge and expertise.

Until the nineteenth century manufacturers were generally shielded from liability resulting from fabricating defective or dangerous products as the society and the courts avoided in getting into the disputes. Caveat emptor was the guiding legal principle. The evolution of the laws governing behavior of the industry brought about a number of legal theories on which actions against anyone in the chain of commerce can be brought: negligence, breach of warranty or strict liability. All three are predicated on the fault system namely, that whoever caused injury to take place is required to fully and fairly compensate the injured party. While the legal aspects of product liability are very complex and interesting areas where engineering and law complement one another, the most significant consequence here is that engineers may be responsible and may be held liable for the damages and/or injuries. A huge

number of cases exist where engineers were held responsible for the consequences of their actions or inactions, for violating safety principles,for ignoring the state of the art approaches, for selecting the wrong materials, for utilizing erroneous design approaches, for not incorporating the appropriate maintenance, and for not anticipating what may take place under given conditions. Ethical behavior mandates that engineers engage fault tree analysis or a like approaches and anticipate what may go wrong and the consequences of that.

Conflict of interest situations take place where engineer's loyalties and obligations may be compromised due to self-interest or other obligations and commitments which lead to biased judgments. Situations in which the proper conduct may be questioned requires that the engineer avoid being put in the position of making decisions which could be challenged later on.

Whistle blowing is a situation in which engineers who are aware of a harmful, illegal and dangerous mode of behavior decide to go public with that information. This may take place in a number of methods: the information may be reported to the appropriate authorities (city, county, state or federal), released to media or a combination of these may be employed. An engineer who is engaged in revealing the information has a serious conflict of interest. The engineer has an obligation to the employer but also to protect the society. Clearly, the protection of the public is paramount and must be held as such. But the consequences may be extreme: the engineer may lose the job and destroy a career, finding a new job may prove to be difficult as employers could be unwilling to hire a potential whistleblower. The effects of such actions may prove very damaging to the family of the engineer and cause a financial disaster. The engineer who engaged in whistle-blowing may be ostracized by the colleagues in the company and in the profession. One must carefully weigh potential consequences of such actions. Still, the gratification of doing the right thing should be a powerful motivator to do just that.

Concern for the environment is an integral part of ethical practices of engineering. Humanity can no longer be the adversary of nature, it must be its ally, its guardian. Careless practices of engineering may destroy complete ecosystems, pollute the air, water and soil, bring about the change in the weather pattern and destroy varieties of life species. We must also be aware of the impact on the protective ozone layer which safeguards plants and animals from the deleterious ultraviolet light. The concept of sustainable development incorporates the requirement of people to live well and improve their standard of living while at the same time protecting the environment. Emphasis on conservation of resources, recycling and nonpolluting technologies are a required mode to reach the sustainable development while reducing our dependence on fossil fuels. Engineers are the only profession that can make efficient usage of renewable energy sources such as solar, wind, biomass, tidal or fission breather reactors. Engineers must develop energy efficient resources and minimize waste and inefficiency.

2   CONCLUSION

It is evident that the engineering ethics is the very essence of the engineering profession. It is the roadmap of behavior of engineers and points out the values and traditions of the profession in leading humanity to make crucial choices and confront the challenges necessary for a better and more meaningful life. The academic engineering community has the difficult and responsible task and challenge of ensuring that future practitioners of the profession are educated and equipped with the skills of confronting the ethical problems, examining the standards of conduct with critical thinking and the competence and ability that are illustrated and taught in engineering classes. This challenge can be met only by making a conscious effort to acquire the understanding of ethical issues by following the test cases which appear on the regular basis in the courts of law, recalls by companies, discussions and seminars presented by professional societies and exercising the utmost dedication and commitment to professional integrity.

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