59 CONVENTION
DHAKA 2019

Engineering Excellence : Earth To Space

Engineers For Leadership in Sustainable Infrastructure Development in Bangladesh

THE INSTITUTION OF ENGINEERS BANGLADESH

HEADQUARTERS, RAMNA, DHAKA 1000

Engineering Ethics: The Essence of Engineering Excellence

Abdullah Al Moinee M-19919
Department of Chemical Engineering, Bangladesh University of Engineering and Technology
Dhaka-1000, Bangladesh, abdullahalmoinee@gmail.com

Abstract

Engineering ethics represents the metaphysics of morals applying to the practice of engineering. The engineering excellence in any field is a function of this pragmatic practice which sustains the intrinsic values to examine and set the regulations by engineers to the people, environment, and earth. The increasing but crucial concerns regarding the growing structures and industries provide a framework from which an exigency of ethical steps is being emerged reflecting the pivotal pathway of sustainable development. In order to glean the reflections to be resulted in engineering excellence, the remarks of ethicality in practice and application are fervently needed to be considered conscientiously in this modern era of far reaching consequences.The engineers have to study the cases extracted from the human history with a view to excavating the problems to be solved escalating experiences by dint of simultaneous implication of ethical and technical standards.They need to develop the paramount of humanity considering the model of professionalism accepted by efficacy of safety and structured by morality with professional ethics.Theengineering ethics designs the perceptive responsibility to realize that the creative profession is persevered and committed to serving the mankind and universe from the earth to space.

1.Introduction

Engineers think, visualize, and function to design the enviable entity by dint of science, technology, and engineering to which the earth, environment, and human being are connected coherently. The impact of engineering implementations is the driving force of civilization that clarifies the cognitive condition of the way earth goes on. According to EPCD (Engineers' Council for Professional Development) engineering is the creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property [1].In 1961, the Conference of Engineering Societies of Western Europe and the United States of America defined "professional engineer" as follows [2]: A professional engineer is competent by virtue of fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. The engineer is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, design, construction, manufacturing, superintending, managing, and in the education of the engineer. The work is predominantly intellectual and varied and not of a routine mental or physical character. It requires the exercise of original thought and judgement, and the ability to supervise the technical and administrative work of others. Engineering education will have been such as to make engineers capable of closely and continuously following progress in the respective branch of engineering science by consulting newly published works on a worldwide basis, assimilating such information and applying it independently. An engineer is thus placed in a position to make contributions to the development of engineering science or its applications. Engineering training will have been such that engineers will have acquired a broad and general appreciation of the engineering sciences as well as thorough insight into the special features of respective branch. In due time an engineer will be able to give authoritative technical advice and to assume responsibility for the direction of important tasks to serve the earth considering the technical, financial, social, and environmental aspects simultaneously.Ethics is a set of concepts and principles that guide in determining what functions helps or harms sentient creatures [3].Thus, an engineer designs the path of engineering to drive by means of respective responsibility in where ethics can catalyze the excellence of development and application. The responsible engineering activity, in this present world of development, reflects the clean technology [4],positive purpose, and the merging zone between business model and professional model. The instability of earth and environment triggers the urge of alteration in business approaches, and manipulation of professionalism and engineering education. The alteration and manipulation are needed for environmental prophylaxis which can be gleaned implying the ideal philosophy of ethics and engineering approaching towards an excellent future. In this era of industrialization and modernization, the perplexities of projects can contribute changing thedecisions and so an engineer should keep in mind that engineering decisions have not only technical but also ethical implications which impact not only the financial well-being but also society, environment, and the earth.

2.Origin of Engineering Ethics

The history of civilization reflects the examples of poor ethical decisions which navigated the notions causing harm to society, community, and environment as a whole. Engineering is a premise of practice in where general mass, apart from the

technical personnel, might incapable of identifying the ethical remarks regarding any project. In the premises of financial and medical aspects, the respective people have to apply and imply their service by the clarified codes and transparent form of ethical rules and regulations which are also well-known to the general people. The ethicality is one of the vital elements of engineering excellence without which critical conditions and perplexed problems may be arisen because many ethical considerations remain in the grey area by being less obvious to the public and often to the respective engineers. Engineering and Ethics bridge the gap together between the intrinsic and pragmatic aspects of psychology to bolster the philosophy of science and technology. A reasonable standard of steps is essential in all engineering projects to reduce the risk [5] which represents one of the most basic ethical obligations for engineers. Critical consequences for example a chemical explosion or structural failure based onself-interests, personal dilemmas, irresponsibility, inadequate design, and research reflects the urge and exigency for a coded ethical consideration of design elements in engineering projects. Thus, the reasons originate the engineering ethics pragmatically which are inherent to engineering endeavor for gleaning the efficacy combining code and conducts, cost effectiveness, environmental stability, and public safety.

3.Ethicality: Elements of Engineering Excellence

Engineers have to function implying the standards of professionalism and codes of ethicality simultaneously by dint of instinctive integrity where ethics is an integral organ to the body of engineering,in order to solve any technical problem.According to National Society of Professional Engineers (NSPE), the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare.Three frames of references: personal, professional, and social structure the engineering ethics through which the ethicality can be considered in two sections: micro-ethics and macro-ethics. Micro-ethics is concerned with personal and professional decisions of integrity spreading in careers of competence, adhering to safety, and ensuring the quality of living. Macro-ethics consists of the collective social and professional responsibilities and liabilities considering public welfare, environment, sustainable development, and bio-ethics on the basis of moral metaphysics. In practicing the ethicsengineers needs to have the tenacity of truth to be cautious about the gap between legal and illegal implications of intellectual property rights in the premises of application.

4.General Principles of Engineering Ethics

Codes of engineering ethics identify a specific precedence with respect to the engineers' consideration for the public, clients, employers, and the profession.Many engineering professional societies have prepared codes of ethics. These statements of general principles served as a guide, engineers still require sound judgment to interpret how the code would apply to specific circumstances.

The general principles of the codes of ethics are largely similar across the various engineering societies and chartering authorities of the world,which further extend the code and publish specific guidance.The followingexcerptions with explanationsarethe fundamental canons designed by National Society of Professional Engineers (NSPE) for engineers to fulfill their professional duties:

1. Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
2. Engineers shall perform services only in areas of their competence.
3. Engineers shall issue public statements only in an objective and truthful manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession and shall act with zero-tolerance for bribery, fraud, and corruption.Engineers shall continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision.Engineers shall, in all matters related to their profession, treat all persons fairly and encourage equitable participation without regard to gender or gender identity, race, national origin, ethnicity, religion, age, disability, political affiliation, or economic status.

5.Case Studies: Extraction of Experiences

The case studies for which Engineering Ethics have beenexplored comprehensively providea clear, concise, and explicit knowledge for extracting enviable experiences.

5.1.Case Study 1: The Space Shuttle Columbia disaster

On February 1, 2003, the Space Shuttle Columbia disintegrated upon reentering Earth's atmosphere, killing all seven crew members. The disaster was the second fatal accident in the Space Shuttle program after Space Shuttle Challenger, which broke apart and killed the seven-member crew 73 seconds after liftoff in 1986.

During the launch of STS-107, Columbia's 28th mission, a piece of foam insulation broke off from the Space Shuttle external tank and struck the left wing of the orbiter. A few previous shuttle launches had seen damage ranging from minor to nearly catastrophic from foam shedding,[6] [7] but some engineers suspected that the damage to Columbiawas more serious. NASA managers limited the investigation, reasoning that the crew could not have fixed the problem if it had been confirmed.[8] When Columbia re-entered the atmosphere of Earth, the damage allowed hot atmospheric gases to penetrate the heat shield and destroy the internal wing structure, which caused the spacecraft to become unstable and break apart.[9]The cause was later discovered transparently as the damage to thermal shielding tiles from impact with a falling piece of foam insulation of an external tank during launch. NASA's investigation team found melted ${}^{26.98}_{13}Al$ on the thermal tiles and inside edges of the left wing of the spacecraft, supporting the notion that the Columbia's destruction was due to hot gases that penetrated the damaged spot on the wing. Mission control deemed that foam shedding was a not a safety factor prior to launch, believed damage of the shuttle panels were not a significant issue. It was not until January 24, 2003, that mission control had classified the damage as a problematic issue. These missteps in communication between mission control and the debris assessment team inhibited a proper examination of the damages to the spacecraft.

5.2.Case Study 2: The Aberdeen Three

Aberdeen is a U.S. Army facility where, among other things, chemical weapons are developed. All three engineers involved in the case were experts in the chemical weapons field and was responsible for developing the binary chemical weapon. The U.S. Army has used the Aberdeen Proving Ground to develop, test, store, and dispose of chemical weapons since World War II. Periodic inspections between 1983 and 1986 revealed serious problems at the facility, known as the Pilot Plant, where these engineers worked. These problems included:

1. Flammable and cancer-causing substances were left in the open
2. Chemicals that become lethal if mixed were kept in the same room
3. Drums of toxic substances were leaking.

There were chemicals everywhere - misplaced, unlabeled or poorly contained. When part of the roof collapsed, smashing several chemical drums stored below, no one cleaned up or moved the spilled substance and broken containers for weeks.[10]When an external sulfuric acid tank leaked 200 gallons of acid into a nearby river, the state and federal investigators were summoned and they discovered that the chemical retaining dikes were in a state of despair and that the system designed to contain and treat hazardous chemicals leaking into the ground. [11] In 1989, the three engineers were indicted for a criminal felony, tried and convicted of illegally handling, storing, and disposing of hazardous wastes in violation of the Resource Conservation and Recovery Act (RCRA).

5.3.Case Study 3: Water Pollution in Bangladesh

According to an industrial survey conducted by Bangladesh Center for Advanced Studies (BCAS) in 2009, only about 40% industries have ETPs (Effluent Treatment Plants). In 10% industries, ETPs are under construction and about 50% industries have no ETP establishment. That is, more than 50% of waste generated by the industries eventually goes to the rivers untreated.In many cases, engineers and managers are considering their financial aspects over the environmental disaster fading the ethical junctures. The Institute of Water Modeling (IWM) and the World Bank conducted a survey of pollution in Dhaka Rivers in 2007 that showed there are over 300 various effluent discharge outlets in the capital and Narayanganj.According to the Environment Conservation Act, 1995 (Amendment 2010), factories which are in "red category" are bound to install and run an ETP.

The pollution spot near the Buriganga Third Bridge experiences huge toxic chemical liquid waste from the Hazaribagh Tannery area through Bashila Khal. There are about 149 tanneries in Hazaribagh which daily generate about 18,000 liters liquid and about 115 metric tones solid waste almost all of which get released into the river Turag through Bashila and Katasurkhals. The other extreme pollution spot is near the Tongi Bridge that derives massive pollutant loading from the Tongi Industrial Area. This industrial area possesses about 29 heavy industries. This cluster of industries of the capital city generates 7,159 kg effluents daily (IWM, 2008). Thus, ETP is an urge to be implemented by each of these industries. The industrial personnel should practice professional ethicality and obligations for engineers so that they can consider the code of ethics and engineering sustaining the financial and environmental aspects simultaneously.

6.Professional Ethicality: Obligations for Engineers

Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical

conduct. The professional obligations published by NSPE in July 2018 are:

1. Engineers shall be guided in all their relations by the highest standards of honesty and integrity.
2. Engineers shall at all times strive to serve the public interest.
3. Engineers shall avoid all conduct or practice that deceives the public
4. Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve
5. Engineers shall not be influenced in their professional duties by conflicting interests
6. Engineers shall not attempt to obtain employment or advancement or professional engagements by untruthfully criticizing other engineers, or by other improper or questionable methods.
7. Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action.
8. Engineers shall accept personal responsibility for their professional activities, provided, however, that engineers may seek indemnification for services arising out of their practice for other than gross negligence, where the engineer's interests cannot otherwise be protected.
9. Engineers shall give credit for engineering work to those to whom credit is due, and will recognize the proprietary interests of others.

7.Conclusion

Engineers perceive that the greatest potential is of their profession is to be committed to serving society, attending to the welfare and progress of the pivotal pathways. Engineers must escalate their awareness of the world as the abode of humanity by transforming nature for the benefit of mankind practicing the philosophy that resonates "Humans are for Humanity". Their dedication and devotion in the universe as a determination are originated from their pragmatic spiritand knowledge designing and structuring the world of sustainable development, writing the safest and sincere way of excellence from earth to space. The psychology of an engineer should be designed on the moral philosophy so that anyproject or paper that might be hazardous or threatening to the environment, life, health, or other rights of human beings, can be renounced with robust reflection. Perceiving the philosophy of science, the philosophy of engineering, and the ethics of technology, engineers need to uphold the esteem of engineering ensuring the proper and peer application. The engineering personnel have to confirm the perpetual development of practical knowledge regarding their respective fields with a view to disseminating the experiences through technical and moral education all around the world. If the engineers are committed to the high standards of conduct e.g. NSPE, as professionals, from the very early stage of their engineering career, then the world can expect the technical and ethical implication of efficient engineering with an altitude of excellence. In order to exhale the essence of engineering excellence by dint of engineering, engineers have to maintain a potential professionalism deeply rooted in altruistic attitude, bold belief, courageous conscience, devoted determination, enviable ethics, endeavor, and enthusiasm, fervent firmness, gracious gratitude, harmonic humanity with honesty, inborn integrity, journey of justice, kindle of knowledge and kindness, loyalty and lucidity, motivation, manifestation, and morality, noblest navigation, optimist origination, persevered patience, quest of quality, robust reflection, synergic strength, tenacious truth and trust, utilization of unity, and visualization of values.

References

[1] Engineers' Council for Professional Development, 1947, "Canons for ethics for engineers."
[2] Christensen, H. S. et al., "Engineering Identities, Epistemologies and Values: Engineering Education and Practice in Context," Vol 2, p.170.
[3] Paul, R. et al., 2006, "The Miniature Guide to Understanding the Foundations of Ethical Reasoning," United states: Foundation for Critical Thinking Free Press, ISBN: 978-0-944583-17-3
[4] Van Der Vorst, R., 1997, "Clean Technology and its impact on Engineering Education," Dissertation, Brunei University, Uxbridge.
[5] Harris, C. E. et al., 2009, "Engineering Ethics: Concepts and Cases," Wandsworth Cengage Learning, ISBN: 978-0-495-50279-1
[6] Columbia Accident Investigation Board, August 2003, "6.1 A History of Foam Anomalies (page 121)."
[7] Spaceflight Now, STS-119 Shuttle Report, 2017,"Legendary commander tells story of shuttle's close call."
[8] Dunn, M., February 2, 2003, "Columbia's problems began on left wing."
[9] USA Today, March 4, 2003, "Molten Aluminum found on Columbia's thermal tiles."
[10] Weisskoph, S., 1989, January 15,"The Aberdeen Mess" The Washington Post Magazine, p. 55.
[11] Rabins, M. J., Harris, C. E., Samsons, C., Flumerfelt, R. W., "The Aberdeen Three, a case prepared under National Science Foundation"Grant Number: DIR-9012252.