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Ethics in the study and practice of engineering: pragmatic and intrinsic values in science and application

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Abstract

This paper will examine many of the ethical constraints and considerations that must be accounted for in the general field of engineering, and will also comment briefly on current trends in the recognition and definition of ethical problems in the engineering field. Through an assessment of in print codes of ethics, intellectual investigations and deliberations on the subject, and a look at numerous case studies, the ethics of engineering will be entirely investigated and broadly examined in a manner that provides concise ,clear and unequivocal knowledge of the engineering ethics. The route this discussion cannot look at every aspect of engineering ethics in this paper's limited capacity, examination from numerous angles and through the use of various resources will provide precise broad view of the issues.

Keywords: Ethics, Engineering, Science, Application.

1. Introduction

As the world becomes increasingly interconnected and interdependent, issues of ethics and ethical missteps have become increasingly common and prominent in the media and in terms of public attention. The worldwide financial crisis is one example of how ethically questionable and/or ethically suspect decisions and behaviors can directly and negatively impact society with international rather than simply localized results. There are many other areas of human endeavors in which poor ethical decisions and behavioral trends have an equal if not greater potential for causing harm to communities, societies, and civilization as a whole, and indeed the issue of ethicality in practice and application is arguably more necessary for consideration in the modern era than at any other time in human history due to the extremity and long reach that the effects of poor ethical decisions have today.

2. Engineering

Engineering is not a field in which the general public might immediately see a host of potential ethical problems. In the financial, political, and medical fields, there are clear and obvious ethical issues that practitioners must contend with in a codified manner generally well known to the public. Here, many ethical breeches are quite obvious and unquestionable when they are brought to light. In engineering, however, many ethical considerations occupy more of a grey area, and they are less obvious both to the public and often to the professionals and practitioners in the engineering field. This can be a source of serious problems. There are both directly pragmatic as well as more intrinsic ethical issues that lie at the heart of engineering practice and even the study of engineering theories and practices.

3. Pragmatic Problems

While ethicality is often seen as a primarily intrinsic aspect of human behavior and decision making, there are also many direct external and practical issues involving engineering decisions that have ethical implications. This can be seen in a variety of ways, from the actual use and application of a specific engineering

theory or project as well as through the actual realities and vicissitudes of how engineering projects actually some about. To put this possibly more clearly, pragmatic ethical issues subsist both in the scientific as well as the interpersonal expansion of engineering projects, and an understanding of these issues is critical.

The Institute of Electrical and Electronics Engineers' (IEEE) code of ethics includes a provision insisting on not only the early detection of problems but also specifically of dealing with problems in any project at the lowest managerial level possible [1]. This has a direct pragmatic purpose, as it leads to the more efficient progression of engineering projects, and a proper use of resources (including time and human resources), in addition to creating a greater sense of personal responsibility for and commitment to specific engineering projects [1].

Adhering to a managerial chain of command also ensures that the values and systems put into place as a part of the project parameters will be adhered to, such that the best interests of the engineering client as defined by that client are adhered to [1]. This is only one example of the interpersonal pragmatic ethical considerations that must be accounted for in a given engineering project.

Other pragmatic ethical concerns in engineering beyond interpersonal and managerial issues can be found in design aspects of engineering projects [2]. A reasonable standard of care is necessary in all engineering projects to minimize the risk of failure for the client [3]. This is one of the most basic ethical obligations for engineers; extreme instances such as bridge failures based on inadequate design and/or research clearly demonstrate the need for a proper ethical consideration of design elements in engineering projects. Even in more subtle cases, risks to personal safety and to productivity and profitability exist for almost any engineering project, necessitating a careful consideration of design factors [3].

The pragmatic ethics that are inherent to most engineering projects are a simple matter of achieving the greatest possible efficacy and efficiency in the given project. In another terms, pragmatic ethical achievement in engineering can be liken to success in the concrete goals of the engineering project - doing the job in the finest approach possible, as well as in terms of public safety, cost efficacy and remaining by the internal regulations and structures of the organization . The fact that this is an ethical imperative in addition to a mere practical concern is reflective of the context in which most engineering projects and applications occur, namely that there are many stakeholders dependent on the successful outcome of any engineering endeavor, and that they are not typically ends in and of themselves[4].

4. Intrinsic Ethics

In addition to the pragmatic and directly practical ethical considerations of a typical engineering project, there are also intrinsic ethical values that exist for almost any engineering theory, mode of study, or application. That is, most engineering elements are useful not only within the scope defined by specific project parameters, but also help to advance the overall science of engineering and other areas of both pure and applied sciences and mathematics [5]. This creates an additional layer of mandatory ethical considerations requiring an even greater level of responsibility and duty of care as the implications of any engineering project (according to this framework) extend well beyond a given engineering project.

It is for this reason that the ethical implications of engineering have increasingly become a matter of study for engineering students at all levels, including in undergraduate survey courses devoted to engineering principles and basic concepts [6]. The qualitative and values-based elements of engineering and of engineering goals are being given increasing attention and importance in engineering programs in order to develop a scientific community that is more reflective of and responsive to the values and beliefs of modern society [6]. Ethical rules such as, "Engineers shall at all times strive to serve the public interest" and, "Engineers shall not be influenced in their professional duties by conflicting interests" demonstrate the types of values that have been determined to be necessary for the continued ethical practice of engineering in the modern era [5].

There is, of course, some overlap in the intrinsic and pragmatic ethics that have been developed for the practice of engineering, and many of the essential intrinsic values of current Western and indeed global society are of course in line with the pragmatic concerns of this society. It is important to note, however, that these values are considered important in and of themselves and not simply for the practical effects that they have, meaning that these values transcend the basic parameters of most engineering projects. Incorporating an understanding of these ethical values earlier in the study of engineering is a part of attempting to make these values a more automatic part of engineering practice and a more foundational part of our society in general, leading to the greater expression of value sin practical concerns as well [6].

5. Case Examples

One of the finest ways to scrutinize the impacts and implications of ethics in the engineering profession is to inspect real-world case that illustrate ethical problems in engineering and the ways in which they were addressed by engineers, government and society at large. Legal

entanglements are almost exclusively the result of negative practical effects resulting from poor ethical decisions, or a misstep in one of the pragmatic areas of ethics, and most often involve a general failure in an engineering project due to neglect, negligence, or even ignorance one the part of engineers.

In most private and government institutions in Nigeria, engineering staff are presumed to know all. A civil engineer can be engaged to do the job of a Mechanical Engineer, electrical engineer, chemical engineer etc at similar time. Rather than looking for services of the qualified engineering professional in field.

Corruption is also a problem. Most engineering venture in Nigeria is carried out via the fifty percent (50%) rule [7]. That is, contractors gives even in excess of fifty percent of the entirety cost of a project to some corrupt government officials and politicians prior to actually embarking on the task and in the majority cases, since the left behind will not be enough to do the job, the task may not be carried, or probably shoddy or deserted.

In Research and Development area: Nigerian Government half-hearted mind-set towards research and development hampers research opportunities in research institutes and universities. Nigerian Government regards research and development to be expensive: due to this there is no connection connecting research institutes, colleges and industries in the nation [7].

Sometimes Non Engineers carry out engineering contract using engineering qualifications in Nigeria: This s done in order to prevail or get engineering contracts.

Most industries and infrastructures in Nigeria are built "once and for all" devoid of any regular maintenance work; the consequence is the decay of infrastructures within the country [8].

Reverse engineering is not even found in the country engineering curriculum; consequently, making technology transfer in some way difficult. Most engineers are not fellowshipping with their contemporaries; many of them occupying managerial positions are not registered with the countries accredited body Nigerian society of Engineers (NSE) and the council for the regulation of engineers in Nigeria (COREN). Consequently, such people seem not concern with the development of engineering and technology in the Nation [7].

There is therefore certain likeness in numerous engineering ethics case studies, and these likenesses can be seen in the following case studies despite the significant differences. In one well-known case, a series of spills, mishaps, and basic mishandlings of a variety of hazardous and toxic materials at the Aberdeen proving grounds, a facility operated by the US Army, resulted in the convictions of three engineers that were also acting as managers of the facility [3]. The guilt of these three engineers was based both on their knowledge of the conditions at the Aberdeen facility as well as their knowledge of the proper care and handling methods and practices necessary for the materials in question, meaning that the responsibility was directly and legitimately traced by the judge in the case according to the knowledge of the individuals being tried [3]. This gives a strong idea of where the ethical onus lies in the practice of engineering.

Another rather more expansive case study can be derived form the current state of bridges in the United States, and the general state of disrepair of many bridges that are still n regular heavy use [3]. A rating system has been developed that determines when a bridge should be put out of commission, but it is not especially definitive in terms of assessing load restrictions or mandating repairs prior to continued use, and thus is largely ineffective in much of what it aims to accomplish [3]. While also ultimately an issue of the failure of an engineering project in its pragmatic intents, this case is considerably different to that of the Aberdeen incident in terms of the degree and type of responsibility borne by engineers. It is not simply a matter of legal negligence, but of true watchfulness and an application of engineering knowledge and theory for the protection of the public interest-in terms of life and in terms of cost-that guides ethical practice in the design and application of engineering projects and control systems.

6. Conclusion

There are, of course, many other cases that could be used to illustrate the ethical considerations that engineers must face in the study and practice of their field. Ethics come into play in most human activities and decisions, and endeavors as important as those undertaken in the engineering field are certainly no exception. The above paper has attempted to impart a broad view of the ethical issues that affect engineering practice, with a mention of the different perspectives and concerns that are a part of this practice.

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