"Don't Fool Yourself" or The Value of Ethics in the Engineering Profession

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Abstract – An adaptation of the famous *Don't Fool Yourself* commencement address by Feynman has been proposed to help improve the learning of ethical principles in engineering classroom, lab and other learning settings. The tools provide a learning model similar to that of Newton, Fourier, and Fick in other more technical courses. The tool has been applied in courses at FAMU-FSU and Tennessee Tech to improve student outcomes in mid-terms and promote sound ethical principles in lab projects.

Keywords: Ethics, life long learning, curriculum, outcomes, feedback.

INTRODUCTION AND MOTIVATION

Concepts and principles related to ethics in the education of the students are very important for a successful career in the engineering profession. In spite of this view, concepts associated with ethical are usually difficult to be conveyed to the students in classroom or lab environments. Some of the reasons are rooted in the "abstract" perception of ethical principles that the students in engineering departments have. Usually, students in technical courses are exposed to a "practical or touchable" view of many concepts. For example, the forces are connected with the second of law of Newton, the heat transfer processes in conduction is captured by the Fourier Law of conduction, the viscous effects in Newtonian fluids, with the Newton Law of viscosity, just to name a few. Such concreted models give the engineering students the perception that they have tools handy for the solution methodologies of problems in different settings. It is the student view that, frequently, in the case of ethical principles, there is a lack of these concrete tools and, therefore, the difficulty in learning such principles from a more abstract fashion.

In his famous commencement address, Noble Laureate and Physics Professor at the California Institute of Technology, Richard Feynman presented an excellent model for the young scientists and engineers to guide their professional life from an ethical point of view. Feynman approached the learning and appreciation of ethical principles from a "scientific view" providing a unique tool for the life long learning of scientists and engineers. In this contribution, the authors will present an adaptation of the Feynman's *"Don't Fool Yourself*" concept that is an effective tool for teaching ethics to engineering students in classroom and lab settings. The approach will review briefly the original Feynman's ideas and then, we will introduce examples used in both classroom and lab settings where students have used them for the formulation of practical approaches guided by strong ethical principles. In general, the approach has received a very positive reception by engineering students and faculty involved. Suggestions for further uses will be offered.

ROLE OF ETHICS IN PROFESSIONAL INSTITUTIONS

Professional Institutions such as societies, private companies, social clubs and many others have all in common a code of ethics that highlights the paramount importance of the role of ethics within the function and objectives of the society or business group. Ethics is the root and vertical column where the organization holds the entire architecture of their existence. It guides their activities and the professional conduct of all the members, from the president or CEO until the last human resource available in the company. Ethical principles make the day to day operation of the organization transparent and the involvement in every activity, credible. The absence of such principles can only lead to poor reputation,

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mal practices and ultimately to the failure of the organization, project or activity. Members that have been affiliated with such business or company will most likely have a difficult time to recovery. One of the most clear examples is of this is the "Challenger Accident" in 1988 and most, recently, the lost of the Shuttle Columbia over Texas in 2003. Both incidents may be related to a break down in the guidelines for professional ethics. A check a re-check sequence most likely was not observed properly and the overconfidence and other factors may have contributed to these fatal accidents. A strong ethical principle being observed by the scientists and engineers may have prevented these accidents by avoiding them to fool themselves with data, evidences, and calculations and ultimately with the judgment needed to decide the course of action. There is never enough precaution taken when lives of human beings are involves in the outcomes.

An outstanding ethical reputation takes years to build but it can be destroyed in a very short time. This characteristic implies the importance of observing and complying with the ethical principles in every professional action and in a continuous manner. Every individual in the organization must observe these principles and have a very high regard for them. Therefore, they become personal habits. In general, these views are known among professional and practitioners. However, the engineering in training, i.e. the students seem to be in a different class and, therefore, it is here where further action is needed. Thus, we believe there is an opportunity to offer an approach that will increase the learning efficiency among the students when they are trained in ethical aspects.

The American Institute of Chemical Engineers, for example, has a code of ethics. One of its statements reads "Issue statements or present information only in an objective and truthful manner" and another, "Perform professional services only in areas of your competence". Both give excellent illustrations of the objectivity and sound expertise required in the professional actions. AIChE also highlights the importance avoiding arrogance by giving credit when is deserved and needed. For example, "Accept responsibility their (employers and clients) actions and recognize the contributions of others; seek critical review of their work ad offer objective criticism of the work of others". Finally, a caring and service aptitude is of crucial importance for the growth of the members within the organization. AIChE, for example, indicates that "continue their professional development throughout their careers, and provide opportunities for the professional development of those under their supervision".

ABET, the engineering accreditation organization also recognizes the importance of the ethics in the education of an engineer during training. Their criterion (f) focuses on "an understanding of professional and ethical responsibility" as one of the outcomes required to be a professional engineer. Since the relevant role that ethics plays in the professional practices of an engineer, it is not surprising that one of the eleven criteria that a student must be trained on, it is on ethics.

By reviewing the analysis above, it is clear that the role and importance of ethical principals permeate all aspects of a professional organization and there is a need to improve the learning of such principles by the students. Furthermore, one could identify the following useful sequence for the need or flow of ethical principles as they relate to the student training in an engineering degree:

Professional Engineer→ ABET Requirements→ Classroom/Lab Training (1)

Some of the questions from an instructional point of view include, for example: How this important principle can be mastered during college training of the future engineer in an efficient way?; What are the possible barriers to learn such principles in engineering education?; Is there an effective approach to achieve the required outcome, efficiently? And, finally: How can instructors facilitate the learning? We use, in this contribution, the well known commencement address by the late Nobel Laureate, Richard Feynman of Caltech, "Do not Fool Yourself" (DFY) as a useful and effective learning tool for acquiring and practicing ethical principles during the training of an engineer. We believe that the DFY principle parallels well other more technical concepts such as the ones identified before and related to heat and momentum transfer.

BASIS FOR THE DEVELOPMENT OF THE TRAINING TOOL

The statement by Feynman is very simple and powerful; it reads as follows:

"The First Principle is that You Must not Fool Yourself-- and You are the Easiest Person to Fool"

Feynman, a great scholar and educator did not hesitate to put such a principle even over other technical-based fundamentals as a pillar of the actions and performance of scientist and engineers. In spite of the fact that ethics have been crearly identified, the learning and practice of such principles seems to be challenging. Moreover, the delivering methods are not quite effective as they should be. We believe that part of the reason is the existence of a barrier in many cases in the process identified below:

$$\textit{Ethics Principles} \rightarrow \textit{Learning and Implementation; } \Delta E_1 \quad (2)$$

By using an analogy with other chemical process, it seems that the activation energy, ΔE_1 is high and prevents an effective delivery to the students. Therefore, *a catalyst* must be added to lower such high level barrier and allow the process to proceed smoothly to the implementation as a personal habit of the scientist and engineer. This catalyst is a life-long learning tool that will help not only the training but also the practice of ethics in the life of a professional engineer. We propose that such a catalyst be the "Don't Fool Yourself Principle" postulated by Feynman. Therefore,

$$\textit{Ethics Principles} \rightarrow \textit{[Don't Fool Yourself]} \rightarrow \textit{Learning and Implementation; } \Delta E_2 \quad (3)$$

will go smoothly and much more effectively than the process (2). In other words, the $\Delta E_2 << \Delta E_1$ since the Feynman principle acts as a very effective catalyst and it is easy and handy for the students and instructors; it is also very practical and concrete to relate to it. In other words, process (3) has removed the abstraction of process (2) because of the effective and powerful catalyzed action of the DFY principle!

Now, some of the reasons why we believe that process (3) is very practical, effective and economical for both instructors and students are based on the following aspects:

- Arrogance vs. Confidence
- Psychological Motivator
- Globally Effective

The use of the Feynman principle helps tremendously with the minimization of personal arrogance and fortifies the individual confidence of the trainee or the professional engineer. It promotes self-confidence based on the practice of good ethics since the principle motivates the universality of its applicability. In other words, it is a good and sound principle that must be followed by the entire community of professionals; therefore, it gives an unifying framework of the learning and practice processes and actions. It avoids the common perception that ethics is some abstract and obscure rule that it is only observe by some elite people. Ethics becomes an integral part of the entire life of a professional, of the instructor and, more importantly, of the students.

Within the framework given by the DFY principle and because of its universal characteristics and because of its good practical implications, ethics now has become a valuable commodity. The Feynman principle is a great motivator for the psychology of the trainee and future engineer. It helps to crystallize prime priorities and honesty, reliability and competence over a sea of competing priorities in the individual choices. Furthermore, it opens and avenue for feedback from faculty, fellow students, and colleagues when they are in the professional life. In fact, it avoids embarrassment and removes defensiveness since everyone can be fooled! Actions for the psychology are not limited to students and trainees but also include faculty. In particular, instructors are usually frustrated with the lack of sensitivity of students to important mistakes. For example, even though it is incorrect by a factor of 1000, the student does not even bother to question whether her/his answer is incorrect! The idea that everybody can be fooled, attenuates the prime frustration from instructors and opens an avenue to furnish feedback. The principle has helped to remove aggressiveness from the faculty towards the students and bring a remedial action immediately.

The Don't Fool Yourself principle provides a unifying effect and a common language through out the entire curriculum when used to train students on ethical aspects. The principle is useful in checking the work performed, looking for trends, evaluating limit behavior and calibrating instruments, all very critical aspects of the learning in the engineering. In a more practical approach, it gives a sound reason for reproducing experiments and verifying data obtained for reproducibility and consistency. In addition, by finding news ways to look at a problem, it promotes creativity and offers all the teams a common language and a common goal. In short, DFY provides an anchoring and concrete tool for both the students and faculty to learn and practice ethical principles.

ILLUSTRATIVE EXAMPLES OF THE TOOLS

The DFY principle has been applied to a variety of situations helping students to avoid fooling themselves and promoting improvement in student performance. This include, for example enhancing student habits to study new material in a course, producing a sound protocol for a lab experiment, conducting efficiently graduate school work, and so on.

During the assessment of the outcomes of a given mid-term, the instructors both at FAMU-FSU College of Engineering and Tennessee Tech University had used the DFY principle to guide students in realizing that there is much more to learn after a mid-term is finished. In particular, if the results of the mid-term were not the expected, students are faced with a number of possibilities. For example:

a- Drop the course and take it later.

b- Change the major for another one, even outside engineering

c- Blame the instructor for a luck of caring

d- Take another look at study habits

e- Take another look at what the instructor has been saying

From this list of possibilities, it is obvious that a-c bring a very negative picture of the student future. Even if at the end, the possibility of taking the course later and even changing the major are options to analyze, they should come only after a thorough study of the student performance based on the an "objective" assessment. Options d-e are much more useful and provide an avenue for, for example, ethical principles to play a role. Within this framework, we have used the DFY tool to guide the student assessment and bring a "different" option to the student outcomes. A brief list of items to consider, by the students, in improving class performance may include:

a-Just because you come to class, you know the material: Clearly, if students take this view, they are fooling themselves. In addition, the students need to organize, complete and clean the material after the class ended. However, if you do all of these activities, you most likely will have only a complete folder/binder of the course. Therefore,

b-Just because you have a good binder, does not imply that you are prepared: Many students seems to believe that because they have good and polished notes, they are prepared for a successful performance. Students still need to remember and quickly identify tools, students need to know when they have to use these tools, they need to know when apply such a tools. In spite of all of this extra work and if all of these items are covered, students will have only a good folder and most likely are prepared. However,

c-Just because students are prepared and have a good folder, does not mean they have the experience to do it: There is a perception among many students that since they have an excellent set of notes and they remember almost everything what is in there, they have a guarantee success in a given mid-term. Still, students must have the experience to do problems, need to know the different cases, identify and understand the different physical situations and be able to recognize cases that they have seen before. But, again, DFY since even if all of these have been performed, students are prepared, have the experience to do it and have a good folder, they need additionally to consider the environment under which the mid-term will take place. Thus,

d-Just because students are prepared, have the experience to do it and have a good folder, does not mean that students are ready: Students need to know how to work under pressure, need to know when to change direction in a given problem that is not yielding physical sound results, and (most likely) they need to reproduce from the top of their head ALL relevant material. As usual, many students seem to believe that a mid-term is just an extension of the peaceful and relaxing homework activities. DFY since pressure will ad a different dimension to the quality of the work and will affect the mid-term outcomes.

We discuss with the students that if they come to class and have observe the series of items a-d, above and therefore, they are prepared, they have the experience to do it, and so on but they think that are ready and (perhaps over) confident, they most likely are fooling themselves since they are the easiest person to fool. In short, trough a series of simple steps, students walk a very effective path towards the use of ethical-like principles that help them to assess objectively an outcome and provide insights for possible sound

corrections. In others works, the DFY tool has catalyzed very efficiently a possible and positive option and, therefore, had effectively remove other very negative options. Other similar approaches have been applied to help students avoid mistakes and getting bad habits in lab settings. In here, students are coached to design a series of steps to identify sound lab practices and observe them constantly when they are working on a given experiment.

ASSESSMENT AND FEEDBACK

As mentioned in Section IV above, we have applied the DFY tools as modified in the template presented for both classroom and lab settings. The students have shown considerable improvement in their study habits and in the way they view ethical principles. The assessment and feedback received from the students and the professors involved that have used the model or principle, is very positive; all have expressed strong satisfaction with the positive effects of the tool, as we described in the sections above, in increasing the awareness on ethical aspects. The DFY principle has been very valuable in catalyzing the process identified in equation (3). Students find no difficulty in adapting the principle to help themselves in other situations such as in lab, classroom or team study. We hope that the same will hold during their professional life.

CONCLUDING REMARKS

We have discussed the tremendous value of the DFY principle originally proposed by Feynman and captured or adapted here in a different way. We believe that such guideline or principle is able to catalyze the usual barriers for the process of learning and practicing ethics. The model brings several beneficial impacts on students learning and their habits that prolong the effect for a life long learning. The tool is simple, removes abstractness and bring a clear and positive way of interacting not only with faculty and students but also with professional in general. The DFY principle identifies the "missing" link between ethical principles and their learning and implementation. It works as the Fourier or Newton law as the guiding principal of transport phenomena!

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