AC 2009-604: KNOWLEDGE OF CONTEMPORARY ISSUES HELD BY ENGINEERING STUDENTS

Enno Koehn, Lamar University

Enno "Ed" Koehn is Professor of Civil Engineering at Lamar University. Dr. Koehn has served as the principle investigator for several research and development projects dealing with various aspects of construction. He also has experience in the design, scheduling, and estimating of facilities. He has authored/co-authored over 200 papers in engineering education, as well as the general areas of civil and construction engineering. Dr. Koehn is a member of ASEE, AACE International, ASCE, NSPE, Chi Epsilon, Tau Beta Pi, Sigma Xi, and is a registered Professional Engineer and Surveyor.

Kishore Gopal Vaska, Lamar University

Kishore was awarded a Master of Engineering (Civil) degree from Lamar University. He has worked as an engineer for Viswashanti Consultants where he assisted in caculating speed flow relationships of traffic along a mid block corridor with varying geometry.

Kartik Paruchuri, Lamar University

Kartik was awarded the Master of Engineering (Civil) degree from Lamar University. He received his undergraduate degree in India.

James Koehn, Chadron State College

James F. Koehn is an Assistant Professor in the Department of Business and Economics at Chadron State College, Nebraska, where he is also the Director of the Nebraska Business Development Center. Koehn currently serves on the Education Advisory Committee of the Nebraska Board of Public Accountancy. He holds Bachelor of Arts and Master of Accounting degrees from Rice University and earned a Juris Doctor from Baylor University. Koehn has worked for an international accounting firm in both their Houston and New York City offices, and he practiced tax and corporate law in Austin, Texas. Dr. Koehn is a member of the American Institute of Certified Public Accountants, Texas Society of Certified Public Accountants, and the State Bar of Texas.

Knowledge of Contemporary Issues Held By Engineering Students

Abstract

The Accreditation Board for Engineering and Technology (ABET) has ruled that students should have a knowledge of contemporary issues. In this regard, it is obvious that, today, engineering is conducted on a global scale and is becoming very important for the nation as well as the whole world. Therefore, every student should pursue knowledge of contemporary and past information regarding various engineering issues.

This paper presents the level of understanding of typical contemporary issues held by the engineering students. It also compares the knowledge of students enrolled at other engineering schools. The data may be utilized by institutions to measure and compare the level of contemporary issues held by their students.

Introduction

Today it is believed that future engineering students will be enrolled in programs that need fundamental changes. For example, at present programs in U.S are falling short in attracting and retaining those who should form the vanguard of the next generation of engineers. According to some sources, the enrollment in engineering programs is decreasing. The present educational system was generally developed in the 1950s and was suitable for that time[5]. But today's first-year engineering students were not even born when this occurred. Today, engineering programs should be conducted on a global scale with industrial practice activities heavily required along with team work projects. Unfortunately, however, some engineering educators discourage teamwork by labeling it as a process in "cheating"[1].

It has been written that currently engineering students are prepared for jobs that don't yet exist using technologies that haven't yet been invented in order to solve problems we don't even know we have[5]. In addition changes are needed in engineering education to address the 3Ns: numbers, needs, and new knowledge[5]. There also is a need for professionals to make changes in the practice of engineering. The 1986 failure of the space shuttle Challenger has become a classic example, with the conflict between engineers and managers providing the kind of dramatic tension that assists students to remember the facts and issues[8,10]. Such case studies may be categorized as recent history, incidents that remain fresh in the minds of professionals. It is important to introduce various other case studies in the class room as they will help students to gain knowledge on contemporary issues.

It may be stated that design is a timeless endeavor and failure an ageless problem. The construction industry may be considered as an example. The nature of construction can be classified as complex, vast, pervasive, diverse, changing and finally evolving. Many research and development programs are being undertaken by the industry. They are conducted mainly for construction companies to excel in regards to strategies driven by cash flow, profit, project schedule and project backlog which means accumulation of unfulfilled orders held by the firm.

Expertise is required in every field to effectively manage a project[2]. This expertise depends, in part, on knowledge and experience with contemporary engineering issues. Knowledge and experience further depends on the availability of new methods or techniques. The study of issues and further research would hopefully lead to a successful project completion. This knowledge of contemporary issues held by engineering/construction students could prove to be beneficial to them as they graduate and become employed by organizations.

Student Perceptions

In order to introduce the required ABET criteria concerning knowledge of engineering and contemporary issues, the senior seminar was revised to include a section on this subject area. A questionnaire was also distributed that was designed to measure student perceptions of various engineering and ethical issues. The findings are illustrated in Table 1 and are described, in part, in the following sections.

Table 1. Questionnaire of contemporary issues.

Engineering Issues	**Student perception**		
	Correct (%)	**Partially Correct (%)**	**Incorrect (%)**
Specifically, What is the number of professional development hours (PDH) required each year to maintain PE license in Texas?	30	5	65
Of the amount in the foregoing question, how many PDH must be in ethics?	65	5	30
ABET also perceives that a knowledge of contemporary issues is important for an engineer. In this regard, a great many children`s toys have been imported from china. What effect did this cause in the united states?	90	0	10

Define FEMA	45	15	40
Regulations require that new facilities in Sabine Pass, TX and New Orleans, LA be built 7-10 feet above grade. Why?	90	0	10
Give an example of how computers may be problem for society, in general, and/or engineering in particular	100	0	0
Engineering today is a global enterprise. For example, India and the people`s Republic of China (PRC) have recently begun international computer and petro-chemical design operations. What effect does this have on “you” or engineering in the United States.	85	0	15
Numerous national/ international engineering firms in Houston and elsewhere employ engineers from India, China and other countries. Some engineers believe this practice should be sharply curtailed. Why?	15	0	85
Why may engineering be considered a “Social Experiment” involving human subjects or clients?	20	15	65
Define engineering ethics.	100	0	0

What is a moral dilemma?	100	0	0
What significant ethical/professional limitation was shown by “Management” in the Challenger disaster?	50	25	25
Describe the change in personal accountability when engineers begin to work under the authority of an organization.	55	0	45
Employed engineers may experience a moral problem in regards to their obligations. What is this dilemma?	35	25	40
Why is conservation (recycling, etc.) ethically justified?	70	25	5
Why should civil engineers be aware of and concerned with national and global issues?	75	5	20
What was the justification for professional codes for ethics to prohibit consultants from bidding for engineering services?	40	0	60
Why were engineering registration laws enacted?	80	0	20
The Texas legislature and the Texas State board of Registration for Professional Engineers mandate that the practice of engineering shall be in keeping with the ethics and practice of which other group(s)?	35	10	55

Professional Development Hour (PDH)

A PDH may be defined as a contact hour (nominal) of instruction or presentation. The Continuing Education Program rule generally requires 15 PDH (Professional Development Hours) per year. In Texas to maintain a professional engineering license at least one PDH must be in the area of professional ethics, roles and responsibilities of professional engineering, or review of the Texas Engineering Practice Act and Board Rules[1]. The other PDH may be meet by coursework, seminars, presentations and technical papers or other activities that are in the area of the rules and responsibilities of professional engineering. If a jurisdiction chooses a biennial or triennial renewal period, the requirement would be 30 PDHs or 45 PDHs, respectively, obtained anytime during the renewal period.

PDH units may be earned as follows:

1. Successful completion or auditing of college credit courses.
2. Successful completion of continuing education courses, either offered by a professional or trade organization, university or college, or offered in-house by a corporation, other business entity, professional or technical societies, associations, agencies, or organizations, or other groups.
3. Successful completion of correspondence, on-line, televised, videotaped, and other short courses/tutorials.
4. Presenting or attending qualifying seminars, in-house courses, workshops, or professional or technical presentations made at meetings, conventions, or conferences sponsored by a corporation, other business entity, professional or technical societies, associations, agencies, or organizations, or another group.
5. Teaching or instructing as listed in paragraphs (1) through (4) above.
6. Authoring published papers, articles, books, or accepted licensing examination items.
7. Active participation in professional or technical societies, associations, agencies, or organizations, including:

    a. Serving as an elected or appointed official;
    b. Serving on a committee of the organization;
    c. Serving in other official positions.

8. Patents Issued.
9. Engaging in self-directed study.

Units: The conversion of other units of credit to PDHs is as follows:

1. 1 college or unit semester hour 45 PDHs
2. 1 college or unit quarter hour 30 PDHs
3. 1 continuing education unit 10 PDHs
4. 1 hour of professional 1 PDH development in course work, seminars, or professional or technical presentations made at meetings, conventions, or conferences
5. For teaching in 1 through 4 above, apply multiple by 2*
6. Publications:

a. Each published paper- 10 PDHs for a reviewed paper or book in the licensee's area of professional practice.
b. Each published paper or 5 PDHs for a article (other than 6.a above) in the licensee's area of professional practice

7. Active participation in 2 PDHs professional and technical societies (each organization)
8. Each patent 10 PDHs
   * Teaching credit is valid only for the first offering or presentation. Full-time faculty may not claim teaching credit associated with their regular duties.

Here only 30% of the students were aware that 15PDH were required to maintain a PE license. Never the less, 65% knew that, in Texas, 1 PDH must be in Ethics.

Ethics

Ethics (Greek *ethos*) commonly refers only to professional behavior[3]. Ethics should be studied to be responsible for and confront moral issues raised by technological activity, to recognize and resolve moral dilemmas and to achieve moral autonomy. A code of ethics isn't something you post on a bulletin board. It's something you live every day. Engineers should uphold and advance the integrity, honor, and dignity of the engineering profession by using their knowledge and skill for the enhancement of the human race; being honest and impartial and serving with fidelity the public, their employers, and clients; striving to increase the competence and prestige of the engineering profession. The virtue of ethics is "The unexamined life is not worth living" [3,4,6]. (Socrates, c.470-399 B.C.). It may be that noticed that 100% of the students were able to define Ethics.

Moral Dilemma

A fundamental principle of morality is that people should try insofar as possible to continue to progress in the moral life. Morality concerns the goodness of voluntary human activity that impacts the self or other living beings[8]. Assuming we have not deliberately allowed ourselves to remain ignorant, powerless, or indifferent, we have complete moral responsibility for what we do with adequate knowledge, freedom, and approval. Morality concerns the goodness of voluntary human conduct that affects the self or other living things. Morality (Latin mores) usually refers to any aspect of human action. Specifically, a moral dilemma is the situation in which two or more moral obligations, duties, rights, or ideals come into conflict[6]. To resolve we must identify the factors, gather facts, rank moral considerations, consider alternative courses of actions, and arrive at a judgment. As with ethics, 100% of the students were able to define a moral dilemma.

FEMA (Federal Emergency Management Agency)

Disaster strikes anytime, anywhere. Disaster takes many forms as a hurricane, an earthquake, a tornado, a flood, a fire or a hazardous spill, an act of nature or an act of terrorism. It builds over days or weeks, or hits suddenly, without warning. Every year, millions of Americans face disaster, and its terrifying consequences. On March 1, 2003, the Federal Emergency Management Agency (FEMA) became part of the U.S. Department of Homeland Security

(DHS). The primary mission of the Federal Emergency Management Agency is to reduce the loss of life and property and protect the Nation from all hazards, including natural disasters, acts of terrorism, and other man-made disasters, by leading and supporting the Nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation. FEMA has more than 2,600 full time employees. They work at FEMA headquarters in Washington D.C., at regional and area offices across the country, and the National Emergency Training Center in Emmitsburg, Maryland. FEMA also has nearly 4,000 standby disaster assistance employees who are available for deployment after disasters. Often FEMA works in partnership with other organizations that are part of the nation's emergency management system. These partners include state and local emergency management agencies, 27 federal agencies and the American Red Cross. It is disappointing that only 45% of the students were able to define the letters FEMA correctly.

Computers may be a problem for society, in general, and/or engineering in particular.

Computers rule the current world. As this is a high technology era, computers have substituted many of our manual or conventional methods of doing a variety of simple procedures. For example, letters have been replaced by emails. But certain software has made a strong impact on students and many professionals using them. People who use software such as Ansys, pro-engineering, catia, CAD, CAM do not generally understand the basic functions or the actual equations that are used to generate the models. This might lower the understanding of results and the analytical skills of various users. Computers these days may also a threat to children. They often get distracted, and often come across material on the internet that is inappropriate. Here, students completing the questionnaire (100%) appear to believe that computers may be a problem.

Conservation (recycling, etc.) is ethically justified.

The basic concept of conservation involves saving resources and developing an eco-friendly environment with the least possible levels of pollution. It also includes minimizing damage to the human race which uses various chemicals and hazardous materials that are potential contaminators and at times lethal to society. For future generations to lead a contented and healthy life, conservation may be necessary and is therefore ethically justified. A forecast or prediction suggests that some resources, due to high consumption, are being depleted and may be gone in a few decades. This could have adverse effect on the planet, earth. Thus conservation is justified. Here, 70% of the students perceive that conversation is important.

Civil engineers should be aware of and concerned with national and global issues.

Civil engineers are responsible for construction ventures that occur on a regular basis. They should be aware of national or global issues as any project that they might be involved with in the near future can add to existing environmental problems[7]. They also should be aware of the consequences of every action they take which might affect the financial condition of the company. To make sure that they do not contribute to monetary problems, students should be aware of natural global issues which may require that important decisions are made. Seventy-five percent of the students agree that knowledge of national and global issues is important.

Engineering registration laws.

In recognition of the vital impact which the rapid advance of knowledge of the mathematical, physical and engineering sciences as applied in the practice of engineering is having upon the lives, property, economy and security of our national defense, it is the intent of the Texas Legislature, in order to protect the public health, safety and welfare, that practitionaries be held to strict compliance with and enforcement of all the provisions of this Act. Only licensed and registered persons shall practice, offer or attempt to practice engineering or call themselves or be otherwise designated as any kind of an "engineer" or in any manner make use of the term "engineer" as a professional, business or commercial identification, title, name, representation, claim or asset. In furtherance of such intent and purpose, the practice of engineering is hereby declared a learned profession to be practiced and regulated as such, and its practitioners in this state shall be held accountable to the state and members of the public by high professional standards in keeping with the ethics and practices of the other learned professions in this state[11]. Here, only 35% of the students were totally informed of all the ramifications of the engineering practice act.

Engineering is considered a "Social Experiment" involving human subjects or clients.

The "Titanic" remains a haunting image of technological complacency. Perhaps all we can take for granted today is that if anything can go wrong, it will—sooner or later. All products of technology present some potential dangers, and thus engineering is an inherently risky activity[6]. In order to underscore this fact and help in exploring its ethical implications, engineering could be viewed as an experimental process[9]. It is not, of course, an experiment conducted solely in a laboratory under controlled conditions. Rather, it is an experiment on a social scale involving human subjects. Engineers are the main technical enablers or facilitators; however, they are far from being the sole experimenters. Their responsibility is shared with management, the public and others. Yet their expertise places them in a unique position to monitor projects, to identify risks, and to provide clients and the public with the information needed to make reasonable decisions. From the perspective of engineering as a social experimentation there are at least four elements that are pertinent:

1. A primary obligation to protect the safety of and respect the right of consent of human subjects.
2. A constant awareness of the experimental nature of any project, imaginative forecasting of its possible side effects, and a responsible effort to monitor them.
3. Autonomous, personal involvement in all steps of a project.
4. Accepting accountability for the results of a project.

It is disappointing that only 20% of the responders assumed this question may be correct.

Knowledge of Contemporary Issues

There are quite a few problems that engineers face in the contemporary world. One of the most important problem is the knowledge of contemporary issues which may assist in the application of engineering concepts. For example, the I-35 bridge collapse in Minnesota should be well known. However, some engineering students are not aware of this event and how it may effect future design procedures[8]. Other colleges and departments have reported similar findings using different questions related to the subject matter of a specific discipline.

Table 1 shows that roughly 69% of the students (62% correct and 7% partially correct answers) were knowledgeable of some of the engineering issues chosen for the questionnaire. It was hoped that the findings would yield a higher percentage, however, they should satisfy the minimum criteria required by ABET for accreditation purposes.

Summary and Conclusion

The findings of the paper have been obtained by using data collected from students and studies published in various journals. The results indicate that during the 21st century every Engineer should have knowledge of the contemporary and especially the global issues related to the practice of professional engineering. In particular, a professional engineer must also follow the ethics, laws and acts related to the licensing procedures. The findings of this paper may be beneficial to students as they graduate and become a member of an organization. For example, being aware of local, national, and global issues could assist a firm to make correct financial and management decisions. Therefore, the issues presented in the paper may assist engineers to be become truly professional and an asset to an organization.

Acknowledgement

The authors wish to recognize Ms. Linda Dousay for her assistance with the production activities involved in preparing this paper.

Bibliography

1) Anon “Application in the Construction Industry Source”, Safety through Design, 2000, p- 217-226

2) Ashford, J. L. (1990). “The management of quality in construction.” E & FN Spon, London.

3) Carpenter, D. “Using a hybrid classroom environment for the instruction of ethics and contemporary civil engineering issues,” ASEE Annual Exposition, 2007, 15p.

4) Lo, J., Lohani. V., Mullin, J. “Introduction of contemporary engineering ethics issues in a freshman engineering course ,” ASEE Annual conference and Exposition, Conference Proceedings, 2006, p13

5) Melsa, James “The forces Driving Change,” Prism, ASEE, volume 17, Number 1 September 2007.

6) Mike M. W. and Schinzinger, R “Ethics in Engineering” second edition chapter 3: Engineering as social Experimentation.

7) Petroski, H. “Changing Study Habits” Prism, ASEE volume 17, Number 5, January 2008.

8) Petroski, H. “Forgetting The Present” Prism, ASEE volume 17, Number 9, Summer 2008.

9) Petroski, H. “Launching a Career” Prism, ASEE volume 17, Number 2, October 2007.

10) Shapira, A. “Contemporary trends in formwork standards-a case study,” Journal of Construction Engineering and Management, v 125, n2, Mar-Apr, 1999, p 69-75.

11) The State of Texas Law and rules concerning “The Practice of Engineering and Professional Engineering Registration,” Austin, TX, page # 3.