Ethics for Industrial Technology Majors: Need and Plan of Action

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ABSTRACT

The recent introduction of sessions dedicated to "Industrial Technology" in the annual ASEE conference is testimony that this discipline has gained its rightful place in the company of engineering and engineering technology. This new level of partnership and collaboration between engineering and technology programs promises to be a step in the right direction for society at large. Engineering and technology majors both supplement and complement each other's knowledge and skills and it is crucial for educators to build bridges of active interaction. This paper takes aim at one specific as well as basic need in teamwork and interdisciplinary projects – ethics and its implications for professional practice. The primary focus here is to promote ethics education among a wider audience that includes industrial technologists.

A preliminary study suggests that students majoring in industrial technology degree programs may not have adequate opportunity to formally study and engage in ethical aspects of technology vis-à-vis the practices of the profession. The core curriculum in industrial technology is typically comprised of technical and business courses with significant variation among individual programs. It is reasonable to assume that the ethical issues or dilemmas faced by an industrial technologist would parallel those that of engineers and managers. The authors, both coming with engineering as well as business backgrounds, coupled with significant experience in teaching industrial technology majors, identify a domain of knowledge that would constitute a necessary background in ethics for industrial technologists. Further, this paper also examines various resources for teaching and makes recommendations from a pedagogical point of view.

Keywords
Curriculum Development, Ethics, Industrial Technology, Society

INTRODUCTION

The college education of engineers and technologists in the United States in the key areas of construction, manufacturing, communications, and transportation manifests itself in the form of three broad degree programs that can be identified as engineering, engineering technology, and industrial technology. Engineering degree programs have a longer history and even though certain misconceptions regarding the profession of the engineer still do exist among the general public, it is fair to state that the profession is well advertised among high school students and the public at large.

In fact, all the fifty states work with the NCEES (National Council of Examiners for Engineers and Surveying) in licensing and maintaining professional competence of engineers (http://www.ncees.org). Engineering technology and industrial technology however, belong to a newer class of degree programs that have generally eluded public knowledge[1]. The four-year "technology" degree programs have been in popular existence for only the past 30-40 years and currently the professions of "engineering technologist" and "industrial technologist" are not regulated by statutory agencies. Certain states allow graduates holding engineering technology degrees to qualify for the title of "professional engineer" by examination. To date, however, a degree in industrial technology does not meet the educational requirements to seek licensure in engineering in any of the fifty states. It is also fair to state that the profession of "engineer" is universally understood; however, the terms "engineering technologist" and "industrial technologist" pose significant ignorance or confusion, especially among educators based outside the United States. The fact remains that we have a large community of engineering and industrial technologists in American industry today and that pool continues to expand on a daily basis.

Although much has been said regarding the distinctive competency of industrial technology, there is overwhelming evidence that the industrial technology curriculum shares significant similarities with engineering and engineering technology (http://www.nait.org). Not withstanding the existing differences in status and mission of engineering, engineering technology, and industrial technology, students graduating from any of these three programs will serve at the forefront of present and future technical marvels. At the very fundamental levels, there should be a core body of knowledge that serves to unite the closely related professions of engineering, engineering technology, and industrial technology. From a societal viewpoint, the industrial technologist's responsibility towards safety and public health equals that of engineers. Due to this reason alone, a curriculum designed to prepare industrial technologists should include the teaching of ethics either as a separate course or blended otherwise. The rest of this paper is directed towards preparing a more substantial case for the formal inclusion of ethics into the industrial technology curriculum, and even more importantly, discusses implementation strategies. The importance of ethics to technical professions is underscored by the emphasis on ethics at the institutional, industrial, and national levels. In fact, during the last five years alone, 78 papers have been presented at the annual ASEE conferences (http://www.asee.org) that discuss teaching ethics in the engineering and technology curricula.

Current Status of Treatment of Ethics in Industrial Technology

The discipline of "Industrial Technology" as we know it today has a relatively short history. Even so, significant contributions, both at the national and international level, have been made by affiliates of the discipline in core areas of engineering and technology[2]. The National Association of Industrial Technology (NAIT) provides leadership and also provides a platform for its associates to constantly expand both the breadth and depth of the discipline. NAIT is also the official body responsible for accreditation and certification. Industrial technology courses often possess an "engineering" flair (e.g., knowledge base). Albeit, these are generally not as mathematically intensive as standard engineering courses. Additionally, more than 25% of regular faculty members that teach in industrial technology programs today have terminal degrees in engineering (http://www.nait.org). Leaders and experts in industrial technology have acknowledged that the discipline needs to adapt and adopt from the best practices of other closely affiliated disciplines such as engineering and business[3]. The accreditation standards for business programs established by the AACSB and similar standards for engineering, established by ABET-EAC, have clearly specified "ethics" in the required content domain. Besides, it is well known that engineering ethics is one of the core areas in the "Fundamentals of Engineering" examination, which must be successfully completed by people seeking the status of registered or professional engineer.

Short of conducting a national survey or similar study, the best way to gain insight into the existing status of ethics in the industrial technology curriculum is to examine the standards for accreditation of industrial technology programs and certification of industrial technologists. The curricular requirements for NAIT accredited Bachelor's degree programs are summarized by its accreditation standard # 6.3.5, more specifically, Table 6.1 embedded under the said clause. A study of this section revealed that ethics was not one of the required subject matter competency areas. It is true that several students may receive some background in ethics through general education courses or open electives. However, the wisdom in hoping that a student gains competency in ethics by chance or assuming that they are not going to enjoy professional benefits from this knowledge is highly questionable. The NAIT certification exam cites four key competency areas identified as production planning & control, safety, quality, and management & supervision. Here again, competency in ethics is not explicitly stated. It may be worthwhile noting that this national exam for certification of industrial technologists is in its infancy, having made its first appearance in 2003.

Further, an examination of curricular requirements across a broad range of NAIT accredited degree programs revealed that an overwhelmingly few number of institutions offered a course in ethics under the auspices of their industrial technology program (http://www.nait.org). Also, we were unable to single out an industrial technology degree curriculum that mandates a course bearing the keyword "ethics". We realize that this observation in itself does not make a case for the lack of coverage of ethics in the curriculum. However, it may be a strong indicator of the presence of a void that this paper seeks to address. It is quite possible that several programs assume that competency in ethics will be acquired through general education courses or open electives. We assert that if this is the case, the assumption is flawed and attempts should be made to correct this by ensuring that competency in ethics is spelled out as a specific requirement.

Current Needs in Treatment of Ethics

Graduates of industrial technology typically accept junior level management roles at the entry level or shortly thereafter. They often provide a critical link between operating staff and senior management. As hands on professionals, they are often not only responsible but also accountable in critical operational areas such as quality approval, workplace hazards and safety standards, compliance with environmental laws, and dealing with customers. Each one of these and other operational areas could potentially pose a myriad of ethical issues. For example, in the quality approval area, the industrial technologist may have the responsibility to maintain records for continued ISO 9000 certification, approve parts that are either being sold to another vendor or end user and she might be given the authority to approve incoming parts from a supplier. The development of new products and services in the 20th century demanded unprecedented levels of interdisciplinary collaboration and teamwork, and the 21st century promises to provide even greater challenges in these areas. The switch to a simultaneous engineering mode of product development requires industrial technologists to be actively involved right from the concept design stage thus posing greater involvement in product safety and environmental issues affecting both society and the individual workplace.

In a recent study[2], the case was made for establishing a code of ethics for industrial technologists much along the lines of those codes that exist for engineers which have been ratified by professional bodies such as the NCEES and ASQ (American Society for Quality). In many ways, this paper complements and augments that argument. We agree with his position and also go further to state that accreditation standards for industrial technology programs should clearly specify ethics in the content domain of knowledge and outcomes assessment. Consistently, the Certified Industrial Technologist examination should reflect appropriate testing of a candidate's knowledge and skill in dealing with potential ethical issues of the profession.

ADDRESSING THE NEEDS

The discipline of industrial technology has had a long history of adapting to the needs of the profession so that it will remain relevant over time. Thus, to help fill this current need in industrial technology programs, several key elements are necessary to consider. Specifically, course content domain, teaching resources, teaching methods, and a subsequent plan of action are all necessary components to successful integration of ethics into mainstream industrial technology curricula.

Content Domain

As a discipline, industrial technology encompasses a distinct body of knowledge which is related to, but separate from, that of traditional engineering curricula. This body of knowledge establishes the framework from which to develop a course devoted to industrial technology ethics. An effective mechanism for establishing potential course content is the examination of textbooks which are currently being used. At this time, however, no ethics textbook solely dedicated to the discipline of industrial technology exists. In order to establish an appropriate content domain for ethics which is applicable to the discipline of industrial technology, an examination of tables of contents from several common engineering ethics textbooks would be useful. These are depicted in Table 1 below. Throughout the table it is evident that many of the topics covered in engineering ethics texts would be equally applicable to the field of industrial technology as well.

Examining Table 1, as well as delving into the substantive content domains of each of these books, has identified several areas of commonality that should be amalgamated and utilized in a course devoted to the ethics of industrial technology. These are outlined in Table 2 below. As this table delineates, the authors recommend essentially seven major focus areas for this type of course. The course should begin with an introduction to ethics, where the student is introduced to this area of study and why it will be essential for their professional careers. Second, the student should be exposed to the foundations of ethical theory, including a brief history of ethical thought, the major theories that are used, and tools for solving problems with moral dilemmas. Third, the student should understand that industrial technology and design are really applications of formal experimentation, and thus safety and responsibility are essential to this field. Fourth, the student should understand the concepts of risk and safety, because the field of industrial technology has many areas where uncertainty abounds, especially those of design and operations. Fifth, the student should learn about the common rights and responsibilities they will have as both employees as well

Table 1. Sample tables of contents from several commonly-used engineering ethics texts.

	Textbook				
Chapter	Fleddermann[a]	Harris[b]	Martin[c]	Mitcham[d]	Schinzinger[e]
1	Introduction	Engineering Ethics: Making the Case	Scope & Aims of Ethics	Is Ethics Relative?	Profession of Engineering
2	Professionalism & Codes of Ethics	Framing the Problem	Moral Reasoning & Ethical Theories	Exploring Different Dimensions of Ethics	Moral Reasoning & Ethical Theories
3	Understanding Ethical Problems	Methods for Moral Problem Solving	Engineering as Social Experimentation	Ethical Theories	Engineering as Social Experimentation
4	Problem Solving Techniques	Organizing Principles	Responsibility for Safety	Ethics & Institutions	Commitment to Safety
5	Risk, Safety, Accidents	Responsible Engineers	Responsibility to Employers	Models of Professionalism	Workplace Responsibilities & Rights
6	Rights & Responsibilities of Engineers	Honesty, Integrity, Reliability	Rights of Engineers	Loyalty	Global Issues
7	Ethics in Research & Experimentation	Risk, Safety, Liability	Global Issues	Honesty	Sample Engineering Codes
8	Doing the Right Thing	Engineers as Employees	Engineers as Managers, Consultants, & Leaders	Responsibility	
9		Engineers & the Environment	Sample Engineering Codes	Informed Consent	
10		International Engineering		Ethical Engineering & Conflict Resolution	
11		Professionalism & Ethics		Engineering & the Environment	

a Fleddermann, C. 2004. Engineering Ethics. Upper Saddle River, NJ: Pearson Education, Inc.
b Harris, C., M. Pritchard, and M. Rabins. 2004. Engineering Ethics: Concepts and Cases. Belmont, CA: Wadsworth Thompson Learning.
c Martin, M. and R. Schinzinger. 2004. Ethics in Engineering. New York, NY: McGraw-Hill.
d Mitchum, C. and R. Duvall. 2000. Engineering Ethics. Upper Saddle River, NJ: Prentice Hall.
e Schinzinger, R. and M. Martin. 2000. Introduction to Engineering Ethics. Boston, MA: McGraw Hill Higher Education.

Table 2. Essential content domain for an industrial technology ethics course.

Introduction to Ethics
Professional environments for industrial technologists
Design processes
Importance of morals in professional life
Defining morals
Defining ethics
Personal ethics
Professional ethics
Moral dilemmas
Why study ethics?
Codes of ethics
What are they?
What are they used for?
What are their limitations?
Corporate climates and ethics
Ethical Theories and Moral Reasoning
History of ethical thought
Ethics of Utilitarianism
Ethics of Rights
Ethics of Duty
Truthfulness
Virtue
Customs and ethics
Religion and ethics
Self interest and ethics
Professional commitments
Methods for moral problem solving
Design and Technology as Experimentation
Design process as a process of experimentation
Need for responsible experimentation
Accountability in design
Industrial standards for design
Commitment to Safety
Definitions of safety
Risk and uncertainty in design
Personal risk vs. public risk
Assessing risks
Accepting risks
Reducing risks
Accidents
Risk-benefit analysis
Workplace Responsibilities and Rights
Employee relationships

Employee responsibilities
Ethical responsibilities
Minimalist
Reasonable care
Good works
Impediments to responsibilities
Honesty
Integrity
Reliability
Confidentiality
Conflicts of interest
Professional rights
Employee rights
Company loyalty vs. whistle blowing
Global Issues
International business
International corporations and economics
Technology transfer
International values and practices
International rights
Human rights
Environmental Ethics
Status of the environment
Stewardship vs. corporations and industry
Stewardship vs. government
Stewardship vs. society
Stewardship vs. economics and costs
Professional Codes of Ethics

as professionals upon graduation. Sixth, with globalization becoming ubiquitous in the professional world, the student should be aware of the broad impacts that industrial technology can have, including international business concepts, as well as environmental consequences as a result of technological applications. Finally, the student should be aware of professional codes of ethics for other disciplines. Although the field of industrial technology does not currently have one established, there is momentum building to institute a code that formally delineates the common ethics for this profession[2].

Teaching Resources

For both instructors who are interested in incorporating individual, specific modules into existing industrial technology coursework at appropriate locations during the semester, as well as those who may design and implement entire ethics courses, supporting teaching materials are absolutely essential to success. Therefore, a comprehensive listing of both recent textbooks as well as current websites (that provide a multitude of case studies) is provided below. Moreover, these references are categorized according to the two disciplines that most closely intersect the field of industrial technology, namely, engineering and business.

<u>Books</u>

Engineering and Technology Ethics

Alcorn, P. A. 2001. *Practical Ethics for a Technological World.* Upper Saddle River, NJ: Prentice Hall.

Beder, S. 1998. *The New Engineer: Management and Professional Responsibility in a Changing World.* Macmillan Education.

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Spier, R. 2001. *Science and Technology Ethics.* Routledge.
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Spinello, R. 2002. *Case Studies in Information Technology Ethics.* Upper Saddle River, NJ: Prentice Hall.
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Business Ethics

Adams, D. and E. Maine. 1997. *Business Ethics for the 21st Century.* McGraw Hill.
Andersen, B. 2004. *Bringing Business Ethics to Life: Achieving Corporate Social Responsibility.* ASQ Quality Press.
Axelrod, A. 2004. *My First Book of Business Ethics.* Quirk Books.
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White, T. 1993. *Business Ethics: A Philosophical Reader.* Upper Saddle River, NJ: Prentice Hall.

<u>Websites</u>

Engineering and Technology Ethics

Case Studies in Economics and Ethics in an Early Biomedical Engineering Class – Vanderbilt University
http://www.vanth.org/docs/003_2002.pdf#search='engineering%20ethics%20case%20studies'
Case Studies in Failures and Ethics for Engineering Educators – University of Alabama
http://www.eng.uab.edu/cee/faculty/ndelatte/case%5Fstudies%5Fproject/
CEE 440: Design Seminar – University of Washington
http://courses.washington.edu/cee440/
Center for the Study of Ethics in the Professions – Illinois Institute of Technology

http://ethics.iit.edu/
Center for the Study of Ethics in Society – Western Michigan University
http://ethics.tamu.edu/
Earthquake Engineering Research Institute
http://www.eeri.org/home/programs_ethics_previous.html
Engineering Ethics – University of Virginia
http://repo-nt.tcc.virginia.edu/ethics/
Engineering Ethics Case Studies – Lake Superior State University
http://asl.lssu.edu/ethics/cases.htm
Murdough Center for Engineering Professionalism – National Institute for Engineering Ethics
http://www.niee.org
Murdough Center for Engineering Professionalism – Texas Tech University
http://www.coe.ttu.edu/ethics/ethics.htm
Philosophy 330: Engineering Ethics – Loyola Marymount University
http://myweb.lmu.edu/jkasmith/phil330.htm
The Internet for Civil Engineers
http://www.icivilengineer.com/General/Engineering_Ethics/
The National Center for Case Study Teaching in Science – State University of New York at Buffalo
http://ublib.buffalo.edu/libraries/projects/cases/ubcase.htm#physics
The Online Ethics Center for Engineering and Science
http://www.onlineethics.org/

Business Ethics

American Institute of Certified Public Accountants
http://www.aicpa.org/antifraud/spotlight/030409_cases.asp
Business Ethics – Sharon Stoerger, University of Illinois
http://www.web-miner.com/busethics.htm
Business Ethics ca – The Canadian Resource for Business Ethics
http://www.businessethics.ca
Business Ethics Case Studies – Colorado State University
http://www.e-businessethics.com
Business Ethics Center – Junior Achievement Worldwide
http://www.ja.org/ethics/case_studies.shtml
Case Studies in Business Ethics – Gruner & Jahr USA Publishing
http://www.inc.com/guides/growth/20806.html
Center for Ethics and Business – Loyola Marymount University
http://www.ethicsandbusiness.org/index3.htm
Center for Ethical Business Cultures – University of St. Thomas, Minnesota
http://www.cebcglobal.org/
Center for the Study of Ethics – Utah Valley State College
http://www.uvsc.edu/ethics/curriculum/business/
Complete Guide to Ethics Management: An Ethics Toolkit for Managers – Authenticity Consulting, LLC
http://www.mapnp.org/library/ethics/ethxgde.htm
Ethics Case Studies – Sharon Stoerger, University of Illinois

http://www.web-miner.com/ethicscases.htm
EthicsCenter.ca – Canadian Centre for Ethics and Corporate Policy
http://www.ethicscentre.ca/
Ethics Update – University of San Diego
http://ethics.acusd.edu
EthicsWeb.ca
http://www.ethicsweb.ca
The Center for Business Ethics – University of St. Thomas, Houston
http://www.stthom.edu/cbes/

Teaching Methods

Although teaching theoretical underpinnings lays essential groundwork, it should not be an end in itself for an industrial technology course. The main objective of this type of course should be to teach practical information and skills to students, so that once they are part of the work force, they will be able to work through the moral issues of specific situations, and will hopefully have the ability to reach reasonable resolutions. Because of this focus, a strong emphasis must be placed in the classroom on the examination of industrial case studies.

Case studies offer students the ability to see beyond the confines of their own educational settings, and to peer into the challenges, problems, environments, and operating conditions of the real world which, unfortunately, many students are never exposed to until graduation. Moreover, well-defined, thorough case studies offer students insights into the strength as well as the frailty of the human condition under the stress of the working world, which they are soon to enter themselves.

Introducing and analyzing case studies in the classroom provides opportunities to teach students how to formally and methodically examine industrial scenarios, and thus hone moral problem solving skills. By using this approach, students can practice discerning relevant facts from opinions, identifying specific moral dilemmas and disagreements, breaking down ethical issues into components, weighing risks and benefits of possible actions, choosing a course of action, justifying this action, and accepting possible repercussions from the choices made.

A challenge for educators is to either develop or find appropriate case studies for use in their own classrooms. The aforementioned teaching resources, which include a fairly extensive listing of textbooks and websites, offer a plethora of case studies. Even though the authors have tried to be exhaustive, many more websites exist which are not listed here, and the reader is encouraged to explore the Internet for more.

Plan of Action

As discussed previously, within the context of the discipline of industrial technology, the essential need for ethics education is currently not being met. To adequately cover the extensive range of topics relevant to this proposal (i.e., Table 2), the authors recommend a full-semester stand-alone course. Understandably, not all academic programs will be able to accommodate this addition with all other programmatic requirements currently in place. Therefore, it is beneficial to examine other mechanisms for incorporating ethics instruction, either as individual topics, components, or units that can be used as specific learning modules, into existing coursework. Many approaches have been found to be quite successful[4]. Some of these avenues include integrating focused ethics components (theory as well as case study analyses) into specific technical courses[5, 6, 7, 8, 9], ethical problem solving during technical problem solving in specific technical courses[10], issues and topics for ethical review during capstone experiences[11, 12], ethics components in coursework dedicated to professionalism[13, 14], topical seminars[15], as well as integration throughout the entire curriculum[16, 17, 18].

CONCLUSIONS

The steady growth in the number of industrial technology programs, both at the two-year and four-year levels, during the past thirty years challenges associates of the discipline to constantly look for ways to identify existing gaps in the college curriculum and address these issues to further increase the value of its graduates and enhance the image of the discipline. Our preliminary research indicates that industrial technology programs should immediately address the issue of developing a core body of knowledge in ethics specifically aimed to be of service to its affiliates. Future revisions of the NAIT accreditation standards should specifically include ethics as a core competency requirement and the Certified Industrial Technologist examination should duly emphasize ethics as an area of testing.

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