This is module on professional ethics is developed to provide a foundational basis for undergraduate engineering students. The following lecture materials are intended to summarize some of the body of literature on the philosophy of ethics, human cognitive development, and moral reasoning. This material is followed by a discussion of engineering ethics and use of the case study method to train engineering students to engage in a reasoned, reflective thought process for evaluating real-life ethical engineering dilemmas. In addition to readings, a case study, and supporting resources on ethics should be provided to enhance the learning experience. Instructors should facilitate the student’s exploration of his/her own moral philosophical beliefs and begin to develop an understanding of his/her cognitive development process.

To develop a working understanding of what ethical thinking and behavior involves, the instructor will need to review ethics assigned readings with the students, introduce them to ethics decision making frameworks and case study analysis, and engage in the class in moral reasoning discussion. The readings, case study, and podcasts are designed to be reviewed and discussed in an effort to stimulate the ability to reason through solutions to ethical dilemmas often encountered in the engineering workplace.

Why Study Ethics?

There are a wide variety of ethical topics that can directly or indirectly influence the professional development of science and engineering graduate students and postdoctoral fellows who will spend their professional lives in the fields of business be it within business institutions-economic profit/non-profit organizations, public/private research laboratory organizations, or academic institutions. Moreover, as most university research is performed by graduate students and postdoctoral students, practitioners in the fields of science and engineering are recognizing the value that instruction in ethics for graduates moving into the workplace is essential to maintain the integrity and quality of the professional and research enterprises. Furthermore, several federal agencies, including the US National Institutes of Health (NIH) and National Science Foundation (NSF), have encouraged and even mandated such training as it relates to the responsible conduct of research (RCR). The American Chemical Society (ACS) Committee on Professional Training has developed guidelines and a Committee on Professional Training Newsletter, Summer 2001. American Chemical Society, Washington, DC.

What is Ethics?

In the study of professional ethics, the skills we want to foster in students should focus on developing what is called in the literature as “prudential judgment.” Prudential judgment asks: in a particular situation, what resources, perspectives, and world-view can inform my decision so I can make the best, most ethical, decision. Therefore, the ethical tools discussed with students training to become professionals in the workplace are better presented as a set of tools that together deeply inform the decision instead of discrete elements that battle with each other. Consider the following approach to explain what ethics and its complexity:

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Ethics and feelings:
What is true is that one should never only consult one’s feelings. Research in the role of emotions and intuition in ethical decision making as well as the discipline of behavioral ethics suggests that our feelings can be powerful indicators that we need to stop and pay attention. Further, our feelings and emotions become the fuel for acting on deeply held commitments, impelling us to act ethically.

- **Biology:** those who study whether or not ethics is genetically predetermined have discovered that we have deeply embedded biases toward actions that are fair and cooperative.
- **Social imprinting:** many of our feelings about what is or is not ethical are shaped during our childhood in our families and communities of origin.
- **Guilt and shame:** The most powerful motivator for assuring ethical action is exclusion from the community if one is unethical.
- **Empathy:** One of the most powerful tools in an educator’s arsenal in enhancing ethical maturity is empathy.

Ethics and Religion
Most ethicists agree that ethics and religion are not synonymous. The task in the Western philosophic tradition at the dawning of the Age of Enlightenment (Kant is one of the early writers) was to separate ethics as informed by religion from ethics informed by reason. This intellectual move allowed the Western tradition to both extricate itself from a fusion with the Christian faith and lay the foundation for religious tolerance and pluralism. On the other side of the coin, every religion includes ethical teachings. Interestingly, every religion has in its expression of ethical teachings different levels of ethical maturity shown in the list of do’s and don’ts and underlying reasons for acting.

Ethics and Law
The law in a very real sense establishes the edges of the proverbial sandbox in which members of the community can play. Thus, from one perspective, one’s ethics begin as bounded by the law as one can do anything that is not prohibited by the law. From another perspective, the law can be a prod to more ethical behavior.

Ethics and Community Values
We are born into community. Our earliest understandings of what is ethical depend almost entirely on the principles, values and resulting behaviors that are accepted by our family and community of origin. As we begin to see other families and study other communities, we expand our understanding of what is or is not ethical.

The crucial questions: Who am I/Who are We?
The study of ethics and choosing to live an ethical life require two vigorous strands of inquiry. One strand asks each of us to define who we are and determine what behaviors flow from that identification. If I say that I am a person of integrity, what behaviors would show that I’m living from that identity? If I say that I am a person of justice, what behaviors would show that I’m living from that identity? The same question gets asked of a community. If we say that we believe that all people are created equal, what behaviors would show that we are living from that
identity? If we say that we believe in financial transparency so people can make their own informed decisions, what behaviors would show that we are living from that identity.

**Moral Philosophical Theories**

The focus here is towards organizing the philosophical theories to highlight the difference between individual and community as well as rationality and sensibility (the philosophical descriptors for emotions and intuition).

As we study the families of ethical theories, the following help us as individual sort out how best to live:

1. **Deontology:** this particular family of ethical theories uses the tools of *rationality* to determine what ethical principles (often translated into duties) *individuals* should embrace as they live in community. Those who favor this family of ethical theories believe that the most effective way to begin the conversation about what is ethical action is to seek what is true (a quest of the mind) for the individual ethical actor.

2. **Consequentialism/Utilitarianism/Egoism:** this particular family of ethical theories uses the tools of *sensibility* to determine what ethical goals an *individual* should seek to promote for themselves and their community. Those who favor this family of ethical theories believe that the most effective way to begin the conversation about what is ethical action is to seek what is good (a study of the heart) for the individual ethical actor.

3. **Justice/Social Contract:** this particular family of ethical theories uses the tools of *rationality* to determine what ethical principles the *community* should embrace as individual behavior is moderated. Those who favor this family of ethical theories believe that the most effective way to begin the conversation about what is ethical action is to seek what is true to determine the agreements for distribution of goods and power among members of the community.

4. **Virtue Ethics:** this particular family of ethical theories uses the tools of sensibility to determine the virtues or qualities of being should be expected of those who exercise particular roles in the community. Those who favor this family of ethical theories believe that the most effective way to begin the conversation about what is ethical action is to seek what is good (a study of the heart) for the those who are called to carry out particular roles in the community.

**In the engineering ethics**, the justice approach to ethics takes center stage. Because so much of engineering focuses on providing services to the community as a whole, balancing the risks and benefits to individuals and the community takes center stage. Individual practitioners are expected to explore issues of risk allocation and benefit to the community as well as be shaped by the the professional codes of ethics which come out of the virtue perspective. Fidelity to these two frameworks cause minimal tension when paired with the two primary frameworks of business – utilitarianism and justice.

**Moral Development**

As we look at the literature about moral development, three questions have framed the research. First, what is meant by moral development and how can I become more ethically mature? Second, is our character stable, so that once we have become more ethically mature we will more likely than not act from the vantage point of our highest level of ethical maturity? Third, why do
good people do bad things?

The notion of moral development was first studied systematically by the psychologist Lawrence Kohlberg. Kohlberg focused on individual moral development and identified six stages through which people could progress over the course of their lifetime. The six stages can be summarized to represent three different levels of concern: At the first level, a person is concerned with his/her own immediate interests and with external rewards and punishments. At the second level, an individual equates right with conformity to the expectations of good behavior of the larger society or some significant reference group. Finally, at the third, or “principled,” level, and individual sees beyond the norms, laws and authority of groups or individuals. Here the person tries to see situations from the vantage point that impartially takes everyone’s interest into account.

Kohlberg’s work was critiqued by Carol Gilligan and Norma Haan who found that the focus on the individual did not adequately consider those for whom maintenance of social relationships (often women) was primary. This school of thought is called the Interactional Theory as opposed to Kohlberg and others who present a Cognitive Theory. Gilligan’s levels of maturity began with the individual and then extended to care of another, and then universal care for all others. Haan begins her stages of moral development with assimilation into the other progressing through being able to maintain moral balance through having one’s own and others mutual interests differentiated and coordinated.3

A Matter of Character
One theory of ethics education is that as we become aware of higher ethical perspectives, we will then necessarily act from those perspectives. The goal of an ethics class is thus to show a better way to live and let people explore and explain the consequences of ethical and unethical action. Then, the expectation is that as individuals engage in habitual ethical behavior, they will not lapse into unethical action. If our character is well formed from childhood forward, we will be people of good character who will behave ethically.

However, a large body of research shows that each of us will be tempted over our lifetimes to engage in unethical behavior, and that absent paying attention and committing to being ethical, we will find ourselves engaging in behavior that we don’t believe represents our “best self.”

Why Good People do Bad Things.
Max Bazerman and Ann Tensbrunsel (2011)4 have recently published a book, Blind Spots which synthesizes the research about why good people ignore unethical behavior.

- **Motivated blindness.** In this situation we have a vested self-interest in ignoring unethical behavior. Whether it be people’s lives who are in danger or data that we would rather not see, each person has to vigilantly commit to seeing clearly what is going on around us.

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• **Indirect blindness.** In this situation we believe that if we have handed off the responsibility of behaving ethically to another, perhaps a sub-contractor or colleague, we are no longer responsible for the unethical action.

• **Slippery slope.** We excuse one tiny infraction of our ethical standards, and then another, and pretty soon we have lost our ethical bearings. Also, by focusing on one item – say our immediate research project or financial goals – we may lose sight of the more complex ethical issues that are in plain view, if we were to look.

• **Valuing outcomes over processes.** Particularly in science the temptation to focus on the results, whether or not harm comes from the action, rather than the process itself can lead to unethical actions. To be ethical one should assure that each of the steps to the goal is ethical in and of itself.

• **Unintentionally rewarding bad behavior.** Behavioral psychologists have found, paradoxically, that punishing bad behavior can reinforce that behavior, because humans focus on what is in their field of vision. To improve a culture and enhance ethical behavior, ignoring bad behavior and rewarding good behavior appears more promising.

So as framed by the research on moral development, the study of ethics thus focuses on all three questions. What is required to become more ethically mature? How do we avoid acting “out of character” and falling into unethical action? How can we be vigilant for the five primary causes of unethical action and assure that, to the degree possible, we and our colleagues engage in ethical behavior.

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**Professional Ethics: Engineering**

**Ethics and the Engineering Professions**

Professions in engineering include the disciplines of aerospace, chemical, computer science, civil/construction, electrical, and mechanical engineering. The disciplines all have as underlying foundations mathematics, physics, and chemistry. What Do Engineers Do? Engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is the link between scientific discoveries and the commercial applications that meet societal and consumer needs.

Many engineers develop new products. During this process, they consider several factors. For example, in developing an industrial robot, engineers precisely specify the functional requirements; design and test the robot’s components; integrate the components to produce the final design; and evaluate the design’s overall effectiveness, cost, reliability, and safety. This process applies to the development of many different products, such as chemicals, computers, power plants, helicopters, and toys.

In addition to design and development, engineers work in testing, production, or maintenance. These engineers supervise production in factories, determine the causes of component failure, and test manufactured products to maintain quality. They also estimate the time and cost to
complete projects. Supervisory engineers are responsible for major components or entire projects.

Engineers use computers extensively to produce and analyze designs; to simulate and test how a machine, structure, or system operates; to generate specifications for parts; and to monitor product quality and control process efficiency. Nanotechnology, which involves the creation of high-performance materials and components by integrating atoms and molecules, also is introducing entirely new principles to the design process. However, acquiring the extensive knowledge and technical skills mandated by schools of engineering to become a capable professional is not all that is required of an engineer.

Professor Joseph R. Herkert⁵ points to the last quarter of the twentieth century which witnessed notable changes in engineering education in the United States, including the recognition of the importance of ethics and social responsibility. He cites the opinions of ethicists about the factors influencing the evolution of the approach change in educating engineering professionals. We learn that spurred by political controversy over nuclear weapons, environmental quality and consumer rights, and changing educational standards promoted by the American Board for Engineering and Technology (ABET), engineering educators began to take seriously the challenge of educating professionals who were both technically competent and ethically sensitive. (Herkert, 2000).⁶

**Ethical Responsibility of the Engineer**

Today, ethics has increasingly become a component of science and engineering professional education. In large measure, this reflects the requirements of ABET that engineering ethics be a part of the curriculum of any accredited engineering program. The ABET accreditation criteria for engineering programs specifies requires, among other things, that engineering programs demonstrate that their students attain “an ability to design a system, component, or process to meet the desired constraints such as …ethical (responsibility)…” and “an understanding of professional and ethical responsibilities.” Also, the National Institutes of Health and National Science Foundation have mandated that pre- and postdoctoral trainees receive some formal education in the responsible conduct and reporting of research. (National Science Foundation, 2011)⁷

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⁵ Joseph R. Herkert is currently Associate Professor of Ethics and Technology at Arizona State University where he teaches ethics of engineering & technology and science, and technology and society courses. Nationally, Professor Herkert has gained prominence for his extensive work in the field of engineering ethics, especially in relation to macro-ethical problems and issues. He is the editor of *Social, Ethical, and Policy Implications of Engineering: Selected Readings*, published by Wiley/IEEE Press in 2000. He has published more than 60 papers, book chapters, encyclopedia articles, and commentaries. His work has been widely cited in the literature on engineering ethics. He has also given numerous presentations at conferences and is in great demand as an invited speaker in both liberal education and engineering environments.


Continuing through the end of the last century, the change in thinking about engineering ethics education gained sustained traction into the 21st century such that today a key concept in engineering ethics is the notion of ‘professional responsibility’ which as discussed previously many ethicists characterize as a type of moral responsibility arising from special knowledge possessed by an individual. Noting that the goals of engineering ethics instruction are the subject of continuing instruction, Herkert confirms general agreement with the sought after outcomes as described by Michael Davis:

“Teaching engineering ethics…can achieve at least four desirable outcomes: a) increased ethical sensitivity; b) increased knowledge of relevant standards of conduct; c) improved ethical judgment; and d) improved ethical will power (that is, a greater ability to act ethically when one wants to).”

Herkert enlightens the student with the shared opinions of engineering ethicists that “…for someone to have a moral responsibility for some matter means that the person must exercise judgment and care to achieve or maintain a desirable state of affairs’. He goes on to make the point that for responsible engineers the sought after state of affairs is ‘the creation of useful and safe technological products while respecting the autonomy of clients and the public, especially in matter of risk taking’.

The literature informs that ethics in engineering programs should be organized around assisting students to acquire some level of understanding of a variety of issues in moral theory and the various moral problems that arise in professional practice and life. However, we are told that the ultimate aim is to provide knowledge and understanding and a degree of proficiency in recognizing, evaluating, and constructing moral arguments on more than one side of a moral issue. Otherwise articulated, there is wide agreement that graduates should be capable of moral problem solving that involves recognizing an ethical dilemma analyzing the situation, and finding a creative middle ground solution. (Sindelar, et al., 2003)

Sindelar, et al., point to the great amount of attention that has been placed on how have perceived, articulated, and resolved ethical dilemmas that have arisen when complex, advanced technologies were developed such as the explosion of the Challenger, the Three Mile Island Nuclear Power plant accident, Chernobol, or the Ford Pinto incident. We are informed that an entire field, disaster ethics has emerged from studying such events.

Sindelar, et al., tell us that the most relevant ethics knowledge that engineers need to acquire are how to recognize and then resolve dilemmas that arise in the routine practice of engineering. One is provided insight that in the performance of their jobs, engineers frequently work under
circumstances that involve ‘under cost’ and schedule pressures which can lead to increased risk. The authors raise the question, “At what point is that increased risk no longer acceptable?”

They also disclose that there are a number of loyalties of the practicing engineer that also contribute to ethical dilemmas. The reader is made aware that there are four constituencies that engineers must show responsibility whose goals may be in conflict. Engineers must show loyalty to their employer, but that engineering practice typically also involves a client or contractor, creating a second level of loyalty. Sindelar, et al., go on to make us aware that there is a third loyalty to the public where safety of the public has been the responsibility of the engineer for two thousand years. The ethicists highlight the fact that every engineering code of ethics places the safety in a prominent position. Finally, we are told that the engineer has loyalty to the profession and to him or herself. (Sindelar, et al., 2003)

As described by group of engineer and science academics of the American Society for Engineering Education (ASEE), engineers in their roles as professionals must often make decisions that involve such factors as environmental effects, product safety and workplace hazards. The ethicists explain that decisions with ethical or moral dimensions may prove to be more difficult than those that primarily involve only production, marketing or financial factors. They warn that ignoring ethical dilemmas can jeopardize a firm’s long-term survival. (Sindelar, et al., 2003).

**Use of Case-based Approach in Teaching Professional Ethics to Engineering Students; use of decision making frameworks**

Not everyone agrees on the role of traditional moral philosophies in ethical decision making or resolution of ethical dilemmas within an organization and the work place in general. Without question, familiarizing students with these theoretical concepts of ethical thought is viewed as essential to gaining a foundational understanding of ethics is viewed helpful by most ethicists. Nonetheless, it is the consensus of science and engineering ethicists that many practical questions would go unanswered if we were to rely solely on moral philosophies to contemplate solutions to ethical dilemmas in professional settings and personal life as well. Also, in the context of professional life, the appeal to one’s personal beliefs or religious traditions may not be enough to adequately deal with the ethical challenges which arise in the professional work place (Davis 1999, 2001).

The Accreditation Board for Engineering and Technology, Inc. (ABET) requires that engineering graduates be prepared to address ethical problems. ABET and engineering ethicists all are in agreement that teaching students to solve ethical problems is challenging as engineering ethics problems are complex and ill-structured with multiple perspectives and interpretations that are driven by the different roles that engineers play which typically have no right or wrong answers. It is for these reasons that the case-based-approach to teaching engineering ethics has been widely adopted as the preferred method of ethics instruction. Further, the use of decision making frameworks developed by scientists and engineers over the last two decades have been strongly encouraged as the tool for analyzing and developing resolution to ethical dilemmas that arise in the engineering workplace environment (Jonassen, et.al 2009, Herkert 2005, Davis, 1999).
This ethics training module adopts the case-based approach to teaching engineering ethics and includes the use of the “Framework for Moral Reasoning”\(^\text{11}\) as the core strategy for engaging students in the process of solving case studies grounded in the context of real-life everyday ethics problems presented in the workplace environment. Everyday ethics problems often involve circumstances where engineers are challenged to balance ethical obligations owed to the corporation to maximize return on investment and professional duties to produce quality work for the safety of the public.

So while the canons of behavior published by engineering associations are norms to be observed by those practicing the profession, these cannons must be supplemented with academic instruction to achieve what engineering ethicists have categorized as the emotional engagement (the willingness to make ethical decisions), intellectual engagement (knowing how to make ethical decisions), and particular knowledge (knowing currently accepted guidelines for ethical practice). The literature informs also the importance of professional engineering ethical codes, moral reasoning and humanist readings. This means that we must help our students to recognize ethical problems; use thoughtful reflection to address those problems by accommodating a variety of perspectives, theories, and ethical codes in their decisions. (Newberry 2004) (Hawes, 2001).

As the instructor for this module, the teaching objectives should focus to:
(1) push students to defend their solutions to ethical problems,
(2) acquire the ability to evaluate alternative solutions from different perspectives, and
(3) enhance students’ divergent thinking (e.g., understand situations from other stakeholders’ point of view).

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\(^{11}\) [http://ethics.iit.edu/teaching/framework-moral-reasoning](http://ethics.iit.edu/teaching/framework-moral-reasoning)


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**Codes and Regulations:**


8. National Center for Professional & Research Ethics (Accessed May 9, 2016) –provides an extensive list of engineering association codes including from the National Society of Engineers and a number of industry and governmental guidelines [http://ethicscenter.csl.illinois.edu/](http://ethicscenter.csl.illinois.edu/) (Accessed May 9, 2016).
