PDHonline Course R115 (2 PDH)

The Right Choice: Applying Ethics to Engineering

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2020

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COURSE CONTENT

It is not enough that you should understand about applied science in order that your work may increase man's blessings. Concern for man himself and his fate must always form the chief interest of all technical endeavors.

---Albert Einstein

1.0 WHY TAKE ETHICS?

Albert Einstein put ethics in perspective. It is not enough to be good in technology, if you have no concern for your fellow man.

How many of you can agree with me that the ultimate ethics test in the United States is the lawsuit, or criminal proceedings? I spent the last twenty-five years of my life dealing with lawsuits. By in large, most of those lawsuits could have been prevented or mitigated by good ethics.

In a story entitled "The Perp Walk," *Business Week,* decried, "Watching executives climb the courthouse steps became a spectator sport in 2002." Dennis Kozlowski, former Tyco International Ltd. CEO was indicted on sales-tax evasion and then, along with former CFO Mark H. Swartz, both were charged with allegedly stealing $600 million from Tyco. Frank E. Walsh, Jr., former Tyco director pleaded guilty to securities fraud. John J. Rigas, former CEO of Adelphia Communications Corp. and his sons Timothy and Michael were arrested and charged they looted $1 billion from the company. ImClone System Inc. founder Samuel D. Waksal pleaded guilty to charges

including securities fraud, perjury, and obstruction of justice. And, then there was Enron, Arthur Anderson (accounting firm), Martha Stewart, and Sanjay Kumar, chairman and CEO of Computer Associates International Inc., all under investigation. The list goes on.

As indictments and convictions increase, ethics will be examined on all levels. Why is this? Simply put, the public demands action. But what is the root cause of these problems? If we look around, we see a society today that is generally hostile to the concepts of:

- **Discipline**
- **Responsibility**
- **Accountability**

We are a society preoccupied with:

- **Failure to accept any personal guilt**
- **Individualism**
- **Lack of respect for authority**
- **Acceptance of "relative morality" with the loss of common values**

We need ethics to avoid illegalities that will change our lives. Anyone who has been in a lawsuit, let alone a criminal trial, knows how life altering that experience can be. But, I assume virtually all of you live within the confines of the law, and that is good. Is that enough? Avoiding illegalities is one reason to think and act ethically, but there is more to life than walking the thin legal limits of the law.

James M. Kouzes and Barry Z. Posner are recognized experts in leadership and have written numerous books dealing with leadership. Principles of ethics and leadership overlap in some areas. Kouzes and Posner have written a book entitled, *Credibility---How Leaders Lose It, Why People Demand It,* where they list as the Number One Fundamental, "Character Counts."

Let me side track for just a moment and say, every trial lawyer who puts a witness on the witness stand to testify for her/his side of the case, always looks at the credibility of the witness. How that witness will relate to the jury. If a witness does not relate well, that witness is

excluded from being called. Unless, of course, they are called by the other side. As a trial lawyer, your client is Exhibit "A" at trial, and if your client lacks credibility, often times a lawyer will not put his own client on the stand. This is precisely why criminal defense attorneys do not put their witness, the defendant, on the stand. That is why O.J. Simpson did not testify and was limited to only putting on the gloves. The Kobe Bryant case fell apart for the prosecution because the accuser's credibility was lacking.

The point I am making is that credibility is really vital in leadership, lawsuits, and life.

Kouzes and Posner discussed Fundamental No. 1 Character Counts, by recalling a conference where Thomas Likona of Santa Clara University's Markkula Center for Applied Ethics, spoke. Likona opened his talk with an anonymous poem that demonstrates character and credibility:

Be careful of your thoughts, for your thoughts
become your words;
Be careful of your words, for your words
become your deeds;
Be careful of your deeds, for your deeds
become your habits;
Be careful of your habits, for your habits
become your character;
Be careful of your character, for your character
becomes your destiny.

Read that poem again more slowly this time. Ethics is not a biological imperative. In point of fact, Ethics is an abstract noun. Abstract nouns name a quality or idea. Ethics begins in our minds. Our mind expresses our Ethics in thoughts and words. Our Ethical thoughts and words transcend into our actions and morph into who we are. Who we are, our legacy, is left to our families, our associates and friends, our clients and customers. Our legacy goes further, our families, sons and daughters, leave our legacy to their families, our associates and friends leave part of our legacy with their associates and friends, and so on. This is why character and credibility are so important and character and credibility start with ethics.

One other point on this topic of credibility and ethics; you have all heard the old cliché, "actions speak louder than words." Character and credibility are shaped by the actions a person does, not what that person says. How many slick, fast talking braggarts, have you known, who are poor performers? Sooner or later, the braggarts' actions belie them, and they are found out. From that time forward, they are labeled by everyone around them as worse than a poor performer. They are branded---liars, and have lost all credibility. It is always much worse than if they had kept their mouth shut and not said anything. Then they are only regarded as poor performers, but nice people, and not liars.

These are a couple of reasons---the law and character and credibility---to take ethics. But, let me share with you why I became so involved in ethics and engineering ethics, in particular. As an undergraduate in metallurgical engineering, I was required to take a humanities course, probably like many of you did. I chose Ethics---Philosophy 3206 at the University of Texas at El Paso. Ethics was taught by the Head of the Philosophy Department, Dr. John H. Haddox. Engineers at UTEP feared the Philosophy and Government Departments in those days because of the extremely liberal professors, who basically had no use for engineers, and the feeling was mutual, I can assure you. Dr. Haddox was different from what we engineers called the "Peadoggies," other non-engineering majors on campus, particularly Liberal Arts majors. (UTEP originated as Texas College of Mines and Metallurgy, an engineering college.) Dr. Haddox' course was intellectually stimulating and with a sense of worth and I left his course with the feeling of wanting to do "good." The point being that I had been exposed to Ethics and left with a feeling of wanting to do "good."

Fast forward my life in time past Georgia Tech and into law school. Law students were required to take one hour of Legal Ethics to graduate. That hour has greatly expanded and now is a large section of the bar exam. Dr. Haddox' Ethics was not the same as Legal Ethics taught in law school. Legal Ethics went straight to the Professional Responsibility Code for lawyers and into the mandated EC's (Ethical Conduct) and DR's (Disciplinary Rules). All of a sudden we weren't learning to be good, we were learning what we could do to not get caught and be hauled before a grievance committee to jerk our license.

Everyone that I know in law school, at least at my law school, hated the course. To make matters worse, about twenty years ago, the State Bar of Texas, in its infinite wisdom and backed by the Texas Supreme Court, decided that each year lawyers must have at least one hour of Legal Ethics as Continuing Legal Education (CLE) to maintain their license to practice law. Did lawyers become more ethical? I think you know the answer---NO! So, they increased the requirement to three CLE hours of Ethics each year. Are lawyers more ethical now? You know the answer to that---NO!

Fast forward my life to about 2001. As a Professional Engineer, we are now going to have continuing education in Texas and other states. And, guess what? We Engineers have to have an hour of Engineering Ethics. As the famous Philosopher, Yogi Berra said, "it's déjà vu, all over again." How do they teach Engineering Ethics? The same way they did in law school. They give examples and then jump to the (Engineering Ethics) Code. Of course, everyone has a different "Code." ASME has a code, IEEE has a code, ASCE has a code, State PE Societies have a code, NSPE has a code, and virtually all the states have statutory codes for engineers. (Later I will discuss useful functions of Engineering Ethics Codes.)

I believe that both the lawyers, and now engineers, are missing the boat when it comes to teaching (Engineering) Ethics. That is why I decided to take it upon myself to study and teach Engineering Ethics. I hope to make disciples of you.

I believe that you must first, think ethically, act ethically, and be ethical, before you ever pick up an Engineering Ethics Code.

First, every Ethics Code is a minimum performance code. Do we really want to teach everyone to be minimally Ethical? That is what we are doing. Second, do we want to use the Engineering Ethics Code like a set of laws? Look at speeding! How many people speed and get away with it? How many people can violate an Engineering Code, Ethic or otherwise, and get away with it?

How do I know I am right that a person must first think, act, and be ethical, before ever using a code? I have observed it for lawyers over the years for one thing. Lawyers are not more ethical today, despite the

fact that they have been taking Legal Ethics in law schools for at least over thirty years, and have had Ethics continuing legal education required for about twenty years (in Texas).

A person whom I admire is Dr. Arthur Dobrin. Dr. Dobrin, author of *Ethics for Everyone—How to Increase Your Moral Intelligence*, and author of some twenty books is the Leader Emeritus of the Ethical Humanist Society of Long Island and Professor of Humanities at Hofstra University. In personal correspondence from Dr. Dobrin, he confirmed what I had observed, "One study done on law students as they entered law school and when they graduated showed that their ethical judgment scores deteriorated during the three years. You're right (meaning me), codes serve as guidelines. Those who look to them as answers tend to think of law and ethics as equivalent." Moreover, the same holds true for medical school and business schools.

I hope I am getting through to you this idea of Ethics. Dr. Dobrin searched for what it means to live a good life in the real world. He observed people "are trying to cope as best they can in a world that rarely stresses ethics." He finds caring for oneself seems to be more important than caring for the community. Dr. Dobrin looks at success, ambition, and self interest as not necessarily bad, but to live the good life, there has to be an ethical setting. His *Ethics For Everyone,* provides a foundation for ethics and examples that everyone faces in life, i.e., aging parents, quality of life decisions, keeping confidences and promises, and a host of others.

I believe the best reason to take ethics, think ethically, act ethically, and be ethical, is that you will be happiest in your life when you are helping someone help themselves. There is a great deal of gratification and satisfaction knowing you are doing the right thing and helping someone else. For example, think how gratified you were when you first taught your child to ride a bicycle. Conversely, you do not feel good when you know you are doing the wrong thing and harming someone else. Unfortunately, if you get in the habit of doing harm to others, each time you do harm, it becomes easier. You begin to rationalize with yourself and become immune to the other person's plight. You become a person of "relative morality" and loose your basic values. At some point, you may even look at some others as sub-human.

Dr. Dobrin succinctly agrees with this reasoning:

"The people who are happiest are mainly those who have learned how to balance their ethical values with other values."

Who does NOT want to be happy? Don't we all want to be happy? I know that as parents, we want our children to be happy. Good ethics makes you happier, which in turn makes your family happier, fellow workers happier, and gives you self-satisfaction as a byproduct. People like to work with people who are ethical. The application of ethics will be even more important in a Global Society.

That is a pretty good motivator---If I am happier, people around me will be happier, and people around them will be happier. Some might say this is pretty idealistic, but wouldn't it be nice to have at least someone shining a light in the darkness. That someone could start with you.

Specifically, what will ethics do for me? Some of the factors attributable to ethics are:

- **Determines our attitude toward life**
- **Determines what makes life worth living**
- **Describes desire**
- **Describes freedom**
- **Describes our rights to opportunities and power**
- **Encapsulates human nature**
- **Encapsulates happiness**
- **Let's us know when life goes well**

The goal then, in this course and in your life, is to Think, Act, and Be Ethical and Apply It to Engineering.

2.0 Can Ethics be Taught?

Before we embark on our thinking, acting, and being ethical journey toward Engineering Ethics, we should investigate whether or not ethics can be taught and learned.

Are we beyond the point of no return in our ethical life? If you haven't learned moral values and ethics as a child is it too late to learn? Are we past the developmental stage of learning ethics? Some people have said ethics *cannot* be taught.

Several years ago an editorial in the *Wall Street Journal* opined that a course in ethics was meaningless because ethics could not be taught. More recently, a *Business Week* story entitled, "Ethics 101 For CEOs" quoted a director for the Center for Corporate Governance at Dartmouth College as saying "You cannot teach ethics to a 55-year-old CEO with a big ego."

The great Christian writer, C.S. Lewis in his book *The Abolition of Man,* seems to agree:

> **"Aristotle says that the aim of education is to make the pupil like and dislike what he ought. When the age for reflective thought comes, the pupil who has been trained in 'ordinate affection' or 'just sentiments' will easily find the first principles in Ethics; but the corrupt man, they will never be visible at all and he can make no progress in that science.**
>
> **Plato before him said the same…"**

Our question is not a new question. It is at least as old as Socrates, whose position was that ethics consisted of knowing what we ought to do and this can be taught. The debate continued until Lawrence Kohlberg, a Harvard developmental psychologist, studied moral development. His moral development theory followed Swiss psychologist Jean Piaget and American philosopher John Dewey. Kohlberg's studies showed that people develop in certain steps that could be identified as stages. Kohlberg's six stages of moral development are:

1. **The first stage is the Stage of Punishment and Obedience, where right is conceived as obeying authority and avoiding punishment as young children.**
2. **The child progresses to the Stage of Individual Instrumental Purpose and Exchange, where what is perceived as right is acting to meet one's needs and allowing others to do the same, allowing fair deals to meet needs. The fairness stage of children.**
3. **The Stage of Mutual Interpersonal Expectations, Relationships, and Conformity. The person defines Right as duties and responsibilities that go along with one's social roles and one's relationships with other people. Loyalty and trust develop as an important virtue.**
4. **The Stage of Social System and Conscience Maintenance, doing one's duty in society and maintaining the welfare of the group is important. Demands of personal relationships take a back seat to the rule of the social group.**
5. **The Stage of Prior Rights and Social Contract of Utility, where rights become upholding the basic rights, values, and legalities of society. Principles of justice dominate personal relationships.**
6. **The last stage is the stage most morally mature people reach, the Stage of Universal Ethical Principles. This stage is characterized by full moral maturity based on faithfulness to abstract principles that all humanity should follow.**

Kohlberg asserted that persons had to go one step at a time in a step by step progression. Moreover, each person had to reach each stage before they could comprehend the next stage.

Kohlberg believed that a person could be taught by presenting them with ethical problems for each stage and having social interaction. Thus, people could be taught all the way to the last stage.

Of course, Kohlberg has his critics to be sure. Nevertheless, Kohlberg's stages for ethical principles are a classic and form a foundation for moral education.

In a more recent summary of moral development, psychologist James R. Rest summarized the findings:

1. **Dramatic changes occur in adults in their 20s and 30s in their dealings with ethical issues.**
2. **The changes are tied to how the person perceives society.**
3. **The amount of change depends on formal education.**
4. **Educational attempts to influence awareness of moral problems and to influence ethical reasoning and judgment have been successful.**
5. **Studies indicate a person's behavior is influenced by moral perception and moral judgment.**

Rest's findings, and that of other researchers, shows that when courses in ethics have challenged persons to look at issues from a universal point of view, they moved upward through the Kohlberg Stages.

The Harvard Business School in a large study relating to leadership, ethics and corporate responsibility found that these principles can be taught in Harvard's MBA program. One of the principals in the study, Thomas R. Piper states:

"Recasting the learning environment and rebalancing our learning objectives are fundamental to the success of the Leadership, Ethics, and Corporate Responsibility initiative. Our words can only reinforce or overshadow what we *are*. The beliefs and attitudes that sustain our courses and our teaching, the conduct that is encouraged and rewarded within our community, the signals that are sent (even unknowingly and inadvertently)---all must be consistent with the ethics program."

The students in the Harvard Business School MBA program range from 24 years old to 30 years old with a average age of 26 years old. Harvard Business School believes ethics can be taught in their MBA program and is committed to it.

Dr. Dobrin compares ethics as the health of the soul and believes in the analogy of exercise and diet for ethics. "Let no one when young delay to study philosophy, nor when he is old grow weary of his study. For no one can come too early or *too late to secure the health of his soul,"* from Greek philosopher Epicurus. Dobrin compares ethics as with running and diet. Some tell us running is good exercise and good for you. Others say running ruins your knees. Some say red meat is bad for you. Others say red meat provides needed nutrients. Similarly, ethics has

competing, and often completely opposite, information. As with diet and exercise, you are never to old to start in the pursuit of what we call ethics.

Dobrin explains the real issue is developing an ethical approach to living. He says Aristotle called it a combination of action, desire, and feeling. Aristotle's feeling, desire, and action, necessarily requires the use of judgment. You use your judgment to apply what you believe to be the right choice for the situation at hand. Dobrin and legal scholar, philosopher, David Luban, opine that good judgment *cannot* be taught through general rules, because you must have judgment to know how the rules apply. You are the focal point of your own inquiry in ethics.

Ethical judgment must be developed through education and practice. Studies in Ethics confirm the old adage, "You are never to old to learn."

3.0 WHAT KOHLBERG STAGE ARE YOU?

Dr. Dobrin has several stories designed to assess your Kohlberg stage. Story 6 is taken from Dr. Dobrin's, *Ethics for Everyone—How to Increase Your Moral Intelligence:*

"Stewart Worked as a detective for many years. Over the years he developed many sources both in government and in industry. When he retired, he decided to work for a private company involved in industrial espionage.

Stewart's work involves gathering information about people such as their social security numbers, investment portfolios, bank accounts, and credit history. He carefully follows the law in obtaining his information.

One day he is asked to work on a big case. The only way Stewart can obtain the information is by having one of his contacts violate a technicality in the law.

Stewart's contact provides him with the information and Stewart passes it on to his employer.

1. **Do you think Stewart did the right thing?**
2. **If you do, why do think it was right?**
3. **If not, why not?**

4. **Do you think Stewart would have been foolish not to use the information provided to him?**
5. **Do you think the law should be followed in all cases?**
6. **Do you think Stewart's contact should have refused to get the information requested?**
7. **What do you see as the most important ethical value in this case?**
8. **What do you see as the major ethical conflict?"**

In evaluating yourself, "there is no right or wrong answer for this dilemma. It isn't whether Stewart passes on the information to his employer, for example, but the reasons you think he should or shouldn't….The questions are designed to look at where you may fit on the Kohlberg scale of moral development. Remember, not all psychologists or philosophers accept this approach. For one thing, it only examines your ideas about ethics. It says nothing about what you might do in real life, although there is a strong indication that a link exists between ethical judgments and behavior in real life."

Try to assess where you stand on the Kohlberg moral development scale. Take this test now and again at the end of this course. Have any of your answers changed? Have any of your reasons changed? Do you look at this problem differently after you have finished the course? Where do you want to be on the Kohlberg scale?

4.0 HOW ARE WE GOING TO ACCOMPLISH OUR GOAL OF THINKING, ACTING, BEING ETHICAL AND APPLYING IT TO ENGINEERING?

The preceding discussion has been leading up to the premise that personal ethics must be the cornerstone for all ethics that follows. Engineering ethics does not exist in a vacuum. It has to be based on the ethical judgment of being able to judge what may or may not be in an engineering ethics code.

Again, how are we going to accomplish our goal? We will study the philosophy of ethics and apply it to engineering, using our ethical thinking, acting and being ethical. To study the philosophy of ethics we

will need some working definitions that we can use to explain certain principles, like using calculus to solve engineering problems. Working definitions that we can use, tools of the trade. Bear in mind that these are working definitions used in a short course, and as such, are not in depth. Volumes have been written about each definition.

The basic definitions we will discuss are: philosophy, ethics, justice, law, engineering ethics, and dilemma.

1. ***PHILOSOPHY*** **Philosophy can be defined as the critical evaluation of all the facts of experience. The term critical implies that the philosopher must view all data and propositions with searching scrutiny, rejecting bias or prejudice of any kind. The key term is evaluation. The philosopher evaluates all facts of experience known to man, as distinguished from the scientist who merely describes selected facts of experience within a special field. It is the act of evaluation that separates philosophy from other disciplines. From *Ideas of the Great Philosophers.***
2. ***ETHICS*** **J. P. Moreland and William Lane Craig believe ethics can be understood as the philosophical study of morality, which is concerned with our beliefs and judgments regarding right and wrong motives, attitudes, character and conduct. As a working definition, we will use ethics as a system of right and wrong, good and evil, a study of standards of conduct and moral responsibility.**
3. ***JUSTICE*** **Philosophers have been debating and trying to define "What is Justice?" since Socrates. I will reference an anthology by the same name, "What is Justice?" for those seeking better definition. We will use a working definition of Justice to mean the use of authority and power to uphold what is right, just or lawful while being fair and impartial.**
4. ***LAW*** **We will look at law, as the philosophers describe, as being a social contract and use *Law,* as rules of conduct established and enforced by authority, legislation, or custom of a given state, community, or other social group.**
5. ***ENGINEERING ETHICS*** **We will define Engineering Ethics as the study of ethical issues arising in engineering.**
6. ***DILEMMA*** **A dilemma is a forced choice between courses of action that are equally bad. A dilemma is like being stuck between a rock and a hard place.**

5.0 WHERE DID WE GET ETHICS AND WHAT IS IT?

Western Ethics emanated from the thinking of the ancient Greeks, philosophers, and theologians. Ethics is generally thought of as a branch of philosophy that is considered a normative science. A normative science is concerned with the norms of human conduct. It can be distinguished from what are called formal sciences such as math and logic and from the empirical sciences, for example physics and chemistry. Ethics is readily discernable from formal science because human attitudes and actions vary from one person to another and are difficult to measure. Moreover, it is difficult to define what a "normal" person really is.

Let is now take a snapshot of the ancient Greeks and philosophers who shaped ethics. This will be a quick look at different philosophical thinking that will aid us in our quest to think ethically, and later apply what we learn to engineering ethical problems or dilemmas.

1. ***SOCRATES.*** **Socrates was Greek who lived in Athens, Greece, from 470-399 B.C. He was considered the "Father of Ethics." Interestingly, he has no writings, but was considered one of the greatest teachers of ethics. Socrates may be best remembered for his expression "the unexamined life is not worth living" and his steadfast belief to look at one's self. He believed in goodness. His method of teaching was to ask questions and lead the person being questioned into a reasoned answer for himself. This technique called the Socratic method is still used in law schools today. Simply put, Socrates' basic philosophy was:**
    - **Virtue is knowledge**
    - **People will be virtuous if they know what virtue is**
    - **Evil is the result of ignorance**

Socrates was known for his questioning of everything essential in nature and purpose. Included in his questioning was the conventional understanding of law, justice, and civil obligation. The citizens of Athens became incensed with Socrates questioning everything, especially when he questioned the law, justice, and civil obligation of the citizens of Athens. Charges were trumped up and Socrates was put on

trial for corrupting the youth. In those days, Athens was a democracy and trial was by jury, except that all the citizens of Athens were included on the jury. In other words, it was a popularity contest. Socrates lost. Curiously, before the trial, Socrates' friends tried to persuade him to leave in exile. He could come back after things calmed down, they told him. Socrates would not compromise his philosophy. When the jury came back with a guilty verdict, Socrates was put to death by drinking the poison, hemlock.

The father of ethics was put to death for what he believed. His legacy continues to be so great that philosophy is often divided into two parts---pre-Socratic and post-Socratic---until this day.

2. ***PLATO.*** **Plato was a student of Socrates, also Greek, and also lived in Athens from 428-348 B.C. The death of Socrates had a profoundly deep effect on Plato. Plato considered Socrates to be one of the smartest men on earth and to watch a popularity contest put Socrates to death, undoubtedly caused Plato to look down with disgust on democracy, and toward a society governed by the educated elite. Society should be governed by reason and not emotional entanglements of life was Plato's philosophy. Plato's work entitled the "Republic" is a cornerstone of philosophical study and views a society where the educated elite rule.**

However, Plato envisioned a society where individualism would be molded by a more important obligation to place society first. This Platonic view places society over the individual. Plato developed character tests for ethical decision making: the Publicity test, Mentor test, Role Model test, and the Mirror test. Using these tests today, one might ask of the Publicity test---what if my proposed actions were reported on TV or in a newspaper, exposing me to the public? The Mentor test might ask if my imagined actions were seen by my parents, coach, professor, or other mentor, what would they think of me? What would my greatest role model think of me, is a corresponding question from the Role Model test? Lastly, and maybe most important test, the Mirror test, might ask, if I do this, will I look at myself in the mirror and feel a sense of pride and dignity or shame and sorrow?

The Plato tests presuppose a person of good character. It is easy to determine that a person of bad character, would not care about the outcome of Plato's tests, because the results would not matter. The person of bad character takes pride in evil and may even do bad for publicity. You only need to look at the beheadings in Iraq to know that Plato's tests mean nothing to those heinous actors, they violate all of them. Moreover, some people just do not care what others think of them. Thus, out of necessity, a person must first be of good character to accomplish the purposes of Plato's tests.

Plato believed that what is honored in a country will be cultivated in that country.

3. ***ARISTOTLE.*** **Aristotle was another Greek philosopher in Athens from 384-322 B.C. Aristotle was a student of Plato's Academy and started at age seventeen.**

Unlike Plato, Aristotle focused on the individual first and foremost. He believed the purpose of government was to aid citizens in the achievement of the good life. Both the individual and society must work together toward the same end or goal. Aristotle's political ideal was a democratic governance that required personal involvement. A democracy will not work if individuals are not involved in the process.

Aristotle expanded on Plato's character philosophy. Aristotle defined "moral virtue" to be the mean or middle between two extremes. He called the two extremes the "excess" at one end and the "deficiency" at the other end. His ethics was then a method to identify the extremes, "excess" and "deficiency" and seek a balance between them. This balance was then what people should try to achieved in their lives.

4. ***IMMANUEL KANT.*** **Kant was born and lived in Prussia from 1724-1804. His ethical principles centered around "duty first." Human beings were endowed with the ability to reason, according to Kant. The ability to reason set certain moral rules by which to live. Rational human beings would abide by the rules set for themselves. Rules derived in this manner would become morally obligatory. Obligation or duty is the key determinant of morality. Kant believed humans could recognize**

duty when they see it, because we humans, have the ability to reason.

Kant believed there were two types of "Duties." There were "Perfect Duties" that had to be observed. For example, do not lie or kill were "Perfect Duties," mandatory to be followed. Kant's second duty was "Imperfect Duties" that were positive obligations, those that did not have to be followed. Examples of "Imperfect Duties" were giving to charity, for good, but not mandatory.

Social order could only come from rules formulated by all and obeyed by all. Kant's concepts were like democracy.

5. ***JOHN STEWART MILL.*** **Mill was English and lived from 1806-1873. Mill's parents used him as an educational experiment. He was completely separated from outside influences and was reading Greek by age three, and by seven, Mill was studying the classics, arithmetic and history.**

Mill believed in utilitarianism with individual rights. He is known for his investigation of the philosophy of utilitarianism. Utilitarianism asserts that our actions should produce the greatest ratio of good to evil for everyone. There are two forms of Utilitarianism. First, there is "Act Utilitarianism," where the right *act* produces the greatest ratio of good to evil. Then, there is "Rule Utilitarianism" where ethical actions and judgments are *based on rules* that promote the greatest ratio or good to evil.

Mill's "Utilitarianism" philosophy was less for the majority's pleasure and more amenable to the individual. In 1859, Mill set out his ethical foundation for democratic individualism, where a person's liberty may justifiably be restricted *only* in order to prevent harm from that person's actions to others.

You have been provided just a glimpse of but five philosophers, whom we will use as our tools to study ethics and later apply it to engineering. There are dozens of philosophers with contributions to the field of ethics. Unfortunately, we are forced to omit them in the scope for this

course. However, the five studied are certainly a consensus key to ethical theory.

6.0 ARE THERE OTHER SOURSES OF ETHICS?

We took a brief glimpse of the philosophers, but just as important to ethics is religion. A large number of people in this world are identified by a form of religion. Dr. Dobrin estimates, in his book, *Religious Ethics—A Sourcebook*, eighty-five percent of the world identifies itself with a religion. When I polled my students at the University of Texas at San Antonio, almost one hundred percent have been associated with some form of religion in their life. When I polled them as to whether they believe in God, it was virtually one hundred percent unanimous, they believed in God. So, the odds are that God and religion play an integral role in peoples' lives in almost the entire world. Many of the engineering ethical problems of today, will affect the rest of the world in the future. It is good to know that God, religion and ethics have common ties in the belief system of most of the world, a common nexus, if you will.

Let us look at the definition of "Religion," before we discuss it. The best definition I have found comes from Dr. Dobrin's, *Religious Ethics---A Sourcebook*, "Religion is that set of beliefs and/or institutions, behaviors and emotions which binds human beings to something beyond their individual selves and fosters in its adherents a sense of humility and gratitude that, in turn, sets the tone of one's world-view and requires certain behavioral dispositions relative to that which transcends personal interests."

Dr. Dobrin goes on to explain, that "religion connects a person with a larger world and creates a loyalty that extends to the past, the present, and the future. This loyalty not only makes demands upon the person but---and this is the part that makes it distinctively spiritual---it creates a sense of humility. *So religion provides a story about one's place in the larger scheme of things, creates a sense of connection and it makes one feel grateful* (emphasis mine)." Thus, religion and ethics have some common goals.

Dr. Dobrin's *Religious Ethics---A Sourcebook,* requested the responses to fifty-five of the same questions asked of different religions. The religions that provided responses were: Baha'l, Buddhism, Christianity (and different denominations), Confucianism, Hinduism, Humanism, Islam, Jainism, Judaism, Scientology, Shinto, Sikhism, Taoism, Vodoun, Wiccan, and Zoroastrianism. These religions include persons from almost the entire world. Studying the first thirteen questions is illuminating and instructive for us:

6.1.1 What does it mean to be a good person?
6.1.2 Why be good?
6.1.3 Is it possible to be a good person and not be a member of your religion?
6.1.4 Is it possible to be a good person and no longer believe in your religion?
6.1.5 Is there a difference between religious requirements and morality?
6.1.6 What is the source of ethics?
6.1.7 Can someone be a good person and be an atheist?
6.1.8 How do you decide what is right and what is wrong?
6.1.9 Why do bad things happen to good people?
6.1.10 Is there a difference between a religious offence and a moral/secular offence?
6.1.11 Who enforces the moral rules of your religion?
6.1.12 Should the moral rules of your religion apply to everyone?
6.1.13 What role should religion play in secular society?

These questions are not only thought provoking questions for religion, but are also basic questions, each of us should answer in our quest to "examine our life" as Socrates advocated. As a gross characterization of the responses, the responses among the religions are surprisingly similar.

The pillars of our individual self, in a quest to be good, are basic ethical values or virtues. Before we discuss values and virtues, we must discuss some of the current philosophical positions. There appear to be three main schools of philosophical thought when evaluating ethical philosophy. Philosophers recognize the duty or deontological ethical theory, the consequential or utilitarian theory

or approach to ethical theory, and the virtue approach or theory of ethics.

Deontological ethics is based upon a reasoned duty and obligation. This type of ethics expects persons to know through reason what their duties and obligations should be and how they should be practiced. What I believe is the down side to this particular theory is that well reasoned duties can lead to very immoral results. As an extreme example, the Nazis reasoned their positions well, but the result was extremely immoral.

Consequential or utilitarian ethics focuses on the consequences of one's actions and tries to develop the greatest good for the greatest number of people. The problem with this school of ethics is that the action or event has to transpire before the result is known. Oftentimes, that is too late, and especially for engineering ethics. I view consequential ethics as the trial-and-error method of ethics.

I believe the foundation or basic belief system for ethics should be virtue ethics. According to Rosalind Hursthouse in *On Virtue Ethics,* virtue ethics has taken the backseat in ethical theory over the last thirty years or so in favor of deontology and utilitarianism. Oddly enough, Hursthouse believes a resurgence in virtue ethics is taking place. (I believe a resurgence of ethics itself is taking place in all fields of endeavor.)

Virtue ethics subscribes to Aristotle's ethics and has as a basis Aristotle's book, *Nicomachean Ethics.* Virtue Ethics depends on individual character, which is really the examination of one's self. Moreover, it gives us some practical guidelines to develop one's self.

It has been my premise from the start, that one has to think ethically, act ethically, and be ethical before the guidelines of an engineering ethics code are viable. If a person is not ethical, the engineering ethics code only gives guidelines to keep a person from getting caught. The engineering ethics code reduces to merely being a "speed limit sign" for the unethical engineer, who is driving with a radar detector.

What are the virtues and values that make up Virtue Ethics? What are these qualities of goodness that keep us grounded in our personal lives? My list is not all inclusive, but I think most would agree with the virtues in the list:

1. **INTEGRITY**
   Integrity may be thought of as moral uprightness and being of strong moral principle and ethics, as well as exercising good and ethical judgment in your field of practice.

2. **HONESTY**
   Honesty is perhaps the pinnacle of all virtues you can have for yourself. Honesty is comprised of truthfulness, fairness, sincerity, and openness. If you are honest with yourself in all aspects of your life, honesty will carry over into your professional life as well.

3. **FIDELITY**
   Fidelity is faithfulness. It is faithfulness to yourself, your family, the public, your employer, your clients, your profession. Fidelity is demonstrated by your continuing loyalty and support to yourself, your family, the public, your employer, your clients, your profession.

4. **CHARITY**
   Charity comprises compassion and mercy for your fellow man, kindness, caring, good will, and tolerance toward all. It is voluntarily giving your help to others.

5. **RESPONSIBILITY**
   Responsibility is accountability, trustworthiness, dependability, reliability, and recognizing a personal and moral obligation to act for the good of others.

6. **SELF-DISCIPLINE**
   Self-discipline is like Aristotle's Golden Mean, not acting in the extremes of "excess" on one end or "deficiency" at the other end. It is not indulging one's self in excessive behavior, either personally or professionally, and instead, acting with reasonable restraint in your life.

These virtues of ethics can be thought of as our "moral compass," pointing us in the right direction, and; as a foundation for our thoughts, actions, and deeds. These qualities of goodness, if followed, will transcend our personal life into our professional life.

6.2.1 The Golden Rule. The one common thread that ties ethics and religion together around the world, is the Golden Rule. It is perhaps the single most important religious and ethical, standard of morality and virtue, the world has to share. For example, John C. Maxwell, in *There's No Such Thing As Business Ethics---There's Only ONE RULE For Making Decisions,* lists the Golden rule as stated in several religions:

- **Christian: "Do to others as you would have them do to you."**
- **Islam: "No one of you is a believer until he loves for his neighbor what he loves for himself."**
- **Judaism: "What is hateful to you, do not do to your fellow man. This is the entire Law."**
- **Buddhism: "Hurt not others with that which pains yourself."**
- **Hinduism: "This is the sum of duty; do naught unto others what you would not have them do unto you."**
- **Zoroastrianism: "Whatever is disagreeable to yourself, do not do unto others."**
- **Confucianism: "What you do not want done to yourself, do not do to others."**

- **Bahai: "And if thine eyes be turned towards justice, choose thou for thy neighbour that which thou choosest for thyself."**
- **Jainism: "A man should wander about treating all creatures as he himself would be treated."**

The Golden Rule is as close to a universal standard for personal ethics as we can find. In John C. Maxwell's *There's No Such Thing As Business Ethics---There's Only ONE RULE For Making Decisions,* the *ONE RULE* is the Golden Rule. According to Maxwell, the sum of ethics is the Golden Rule, and there are only two important points about it. One, the Golden Rule is the standard to follow. Second, is the will to follow the Golden Rule. Maxwell deals primarily with business and business leadership, but his point is well taken to consider for all ethics, including applying ethics to engineering.

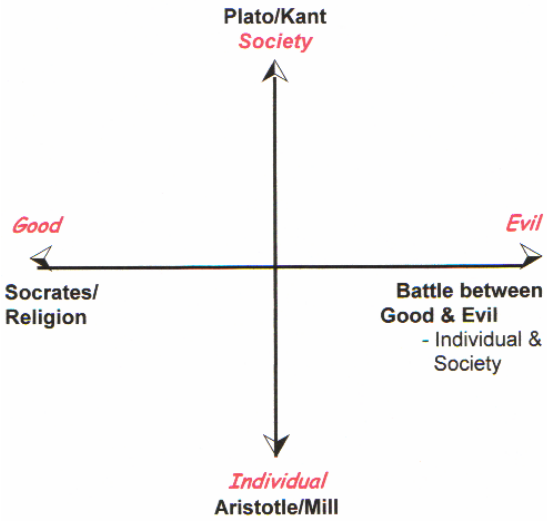
7.0 WHAT, THEN, IS THE PROBLEM IN ETHICS?

In his book, *Ethical Know-How---Action, Wisdom, and Cognition,* the French researcher Francisco J. Varela described Ethics as "closer to wisdom than reason, closer to understanding what is good than to correctly adjudicating particular situations."

A decision is an ethical decision when it concerns conduct that has major consequences for human well being. Commensurate with ethical decisions is the requirement that the decision maker must be able to justify her/his decision based on rules or principles.

I liken ethical decisions as having too many variables and not enough equations. In ethics the exceptions tend to consume the rule. With this in mind, I have tried to present some order and logic to the ethics problem and to be able to "see" what is going on with ethics. To be able to "see" the overall order and concept to ethics, I developed a graph that I refer to as "THE PROBLEM."

"THE PROBLEM"

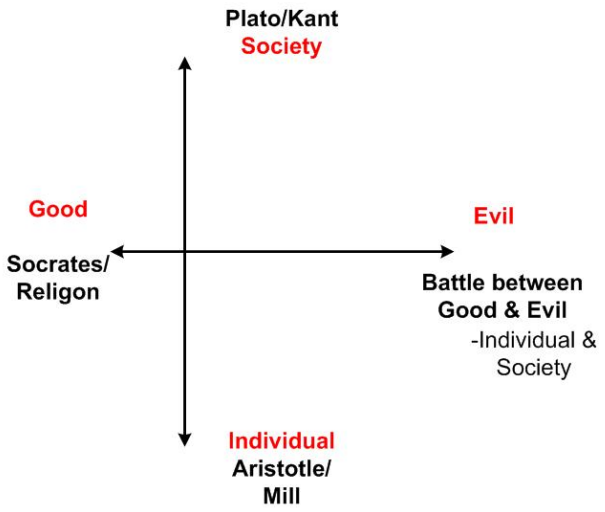


WHAT IS:

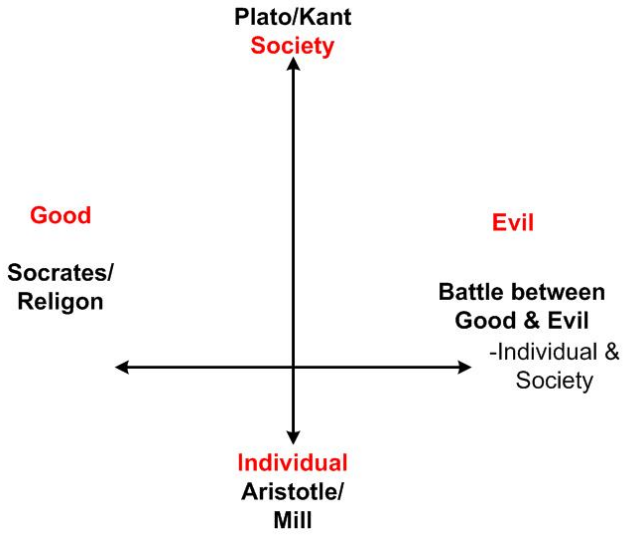
- EVIL?
- GOOD?
- SOCIETY?
- INDIVIDUAL?

The figure above shows an optimized condition.

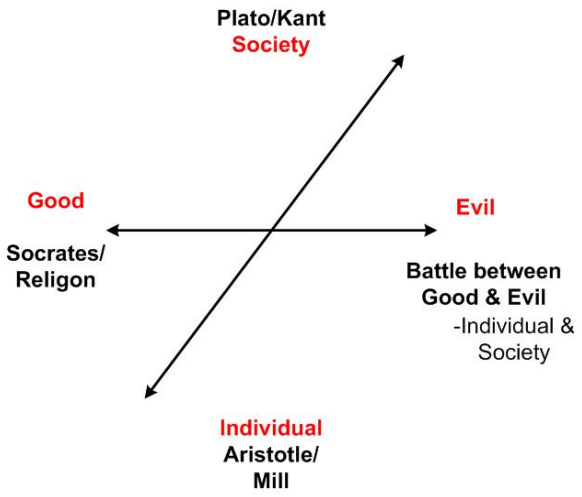
Try to imagine, life as a conflict between Good and Evil on the X-axis and the conflict between Society and the Individual on the Y-axis. Now, try to visualize the Y-axis of Society/Individual being able to move left and right along the X-axis. Thus, allowing Society/Individual to move toward Good or Evil, i.e. good in the figure below.



Again, try to picture, the X-axis of Good/Evil being able to move up or down on the Y-axis of Society/Individual. This allows Good /Evil to rise or fall toward Society/Individual, i.e. toward the individual in the figure below.



Lastly, visualize rotation of these axes. The result is a picture of the completing forces for ethical resolution. (below)



Of course, this is a hypothetical figure of ethical forces and does not have the quantities of the forces.

"The Problem," hopefully, allows you to "see" the competing forces in a dynamic situation of ethical thought. The competing interests of our philosophers is also pictorially depicted. We see the pro-society positions of Plato and Kant, opposed to the completing positions of Aristotle and Mill. The philosophy of Socrates, the father of ethics, and religion, representing the force of good. The forces of Evil might be represented by Adolph Hitler.

Thus, "The Problem" demonstrates visually, at least, the concept that when something good is done for society it affects the individual and is evil toward the individual. By the same token, what is good for the individual is evil toward society.

The questions of what is EVIL, GOOD, SOCIETY, and INDIVIDUAL are the questions philosophers have argued over for centuries. Evil may be thought of as despicable immorality, wickedness, and has been thought of as a supernatural force. It is the opposite of good. Good may be thought of as morally right, ethical, and righteous. Good has been thought of as a standard of positive moral and spiritual quality by which people and events are judged. Society is the congregation of people living together in a particular grouping, country, or region and sharing similar laws and/or customs. Individual is a single member of a group, class, or family, and may be a human or a fictitious person such as a corporation.

Although we can define Evil, Good, Society, and Individual, in practice it is very difficult to assign a quantity or magnitude to them. Moreover, diversity adds another dimension to them.

Diversity is defined as otherness or those human qualities different from our own and outside the groups to which we belong, yet is present in other individuals and groups. Pictorially, we might think of diversity as a Z-axis.

Diversity has two components, primary diversity and secondary diversity. Primary diversity is those things that cannot be changed such as age, ethnicity, gender, physical qualities, race and sexual orientation. Secondary diversity is those things that can be changed such as educational background, geographical location, income, marital status, military experience, parental status, religious beliefs, and work experiences.

So, the stage is set, by way of "The Problem," to keep in mind the graph, as we focus on ethical situations, that we will be confronted with in our lives, both personal and professional.

8.0 WHAT ARE EXAMPLES OF "THE PROBLEM" IN ETHICS?

Let's test "The Problem." Remembering that our working definition of ethics is a system of right from wrong, we will look at some examples.

As you read though these questions, THINK about how you would answer the question yourself and then think about whether anyone might oppose your answer.

1. **Murder (defined as killing an innocent human). Do you believe murder is wrong? When I ask this question of my students, virtually all agree murder is wrong, as do the different religions in Dobrin's *Religious Ethics.* But change the facts and the answers change and become more diverse. Do you believe it is wrong, if:**

- **The military is at war?**
- **Civilians are killed, wrong or justified?**
- **What are civilians? Munitions workers, justified or not?**
- **Abortion? Good or Evil? (students are split 50/50)**

2. **Design/Manufacture of handguns---Good or Evil for Society?**
   - **Police handguns as weapons, Good or Evil?**
   - **Small caliber "Saturday Night Specials," Good or Evil?**

3. **Motorcycles, Good for Society?**
   - **Should Society mandate helmets for riders, yes or no?**
   - **Should the Law treat motorcycles differently, yes or no?**

4. **Automobiles, Good or Evil for Society?**
   - **Airbags mandated, Good or Evil for Society?**
   - **Safety features, mandated by Society or not?**
   - **Mandated environmental controls, yes or no?**
   - **Mandated gas mileage?**

5. **Airplanes, Good or Evil for Society?**
   - **Are airplanes, safe or not safe enough for Society?**
   - **Should pilots carry guns to protect passengers?**
   - **Should passengers be screened, to what extent?**
   - **Should passengers be made to disrobe?**
   - **Should full body x-ray scans be allowed?**
   - **Should ethnic profiling be used on passengers?**

6. **Nuclear Plants, Good or Evil for Society? (engineering students and local ASM, ASME engineers more than 95% say good).**
   - **If good for Society, safe or not safe?**
   - **How safe is safe?**

7. **Welfare, Good or Evil for Society?**
   - **Welfare for the handicapped, yes or no?**
   - **Welfare for the unemployed, yes or no?**
   - **How much are you willing to donate to welfare? Directly or through taxes?**

8. **Is Business as we know it, Good or Evil for Society?**
    - **Should additional laws be required to protect Society from bad business practices?**
    - **Should bribes, money paid to obtain the sale, be allowed? In the United States? Other countries as part of doing business?**
    - **Should gratuities, tips or gifts after the sale, be allowed? If so, how much? What is the difference between a bribe and a gratuity?**
    - **Charging interest on business transactions, should it be allowed? How much?**
    - **Should business be based strictly on a contract or should other rules apply?**

9. **Global Economy, is it Good or Evil for Society?**
    - **Good or Evil for the United States?**
    - **Good or Evil for other countries of the world?**
    - **Will the Global Economy separate further the countries of the world into the "haves and have nots"?**

10. **Environment?**
    - **Do we humans belong to the environment, or does the environment belong to us?**
    - **Should global environmental laws be put in place and enforced?**

11. **Organized Religion, is it Good or Evil for Society?**
    - **Can Society do without Organized Religion?**
    - **Have you ever been affiliated with Organized Religion?**
    - **Is Organized Religion in government, good or evil for society?**
    - **Should government run Organized Religion, or should Organized Religion run government?**

12. **Have you ever lied in your lifetime? Depending on the lie, you may be predisposed to violating ethical standards. (Virtually everyone has lied in their lifetime that I have polled.)**

13. **Have you ever stolen anything in your lifetime? Again, depending on the circumstances you may be predisposed to violating ethical standards? (Most of the people I have polled, admit to stealing in their lifetime.)**

WHAT IS THE PURPOSE OF THESE QUESTIONS?

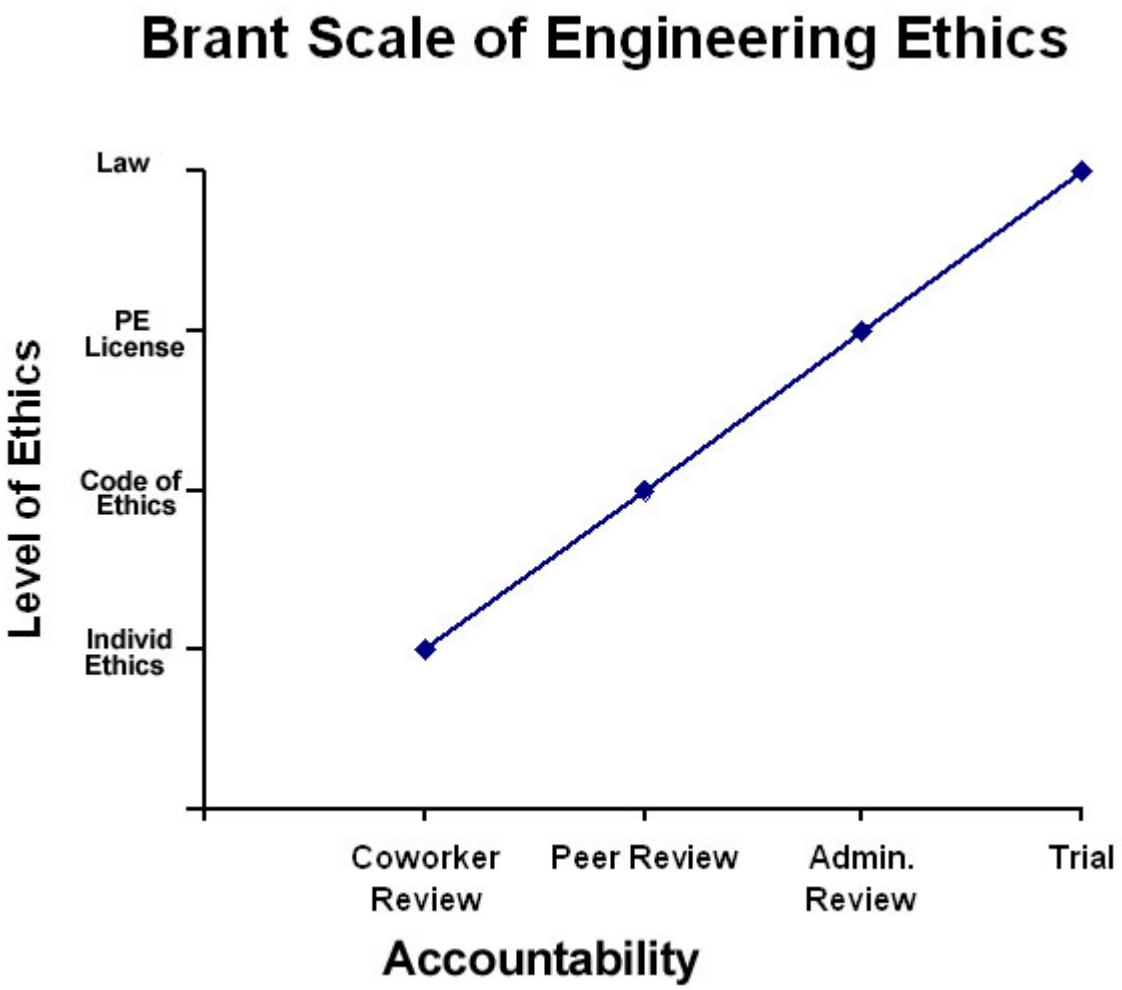
The purpose of these questions is to illustrate that opinions of Good and Evil vary, that opinions regarding the Individual and Society vary, and to expose you to the fact that some people might think your behavior/thought process might not be ethical. Secondly, the purpose is to prepare and caution you of predispositions toward behavior that might not be ethical.

Our ethics system of right and wrong varies, particularly, when diversity or otherness is a factor. We need to find some common ground to build a foundation as our basis.

9.0 HOW DO WE BUILD A FOUNDATION OF RIGHT AND WRONG?

We are concerned now with building a foundation for engineering ethics, by applying ethics to engineering.

In the next figure, I have tried to present what I call the "Brant Scale of Engineering Ethics." The scale shows how ethics escalates in the practice of engineering. As we grow in accountability, our level of ethics increases.



As the required Level of Ethics increases, so does Accountability; the ultimate being a trial to determine guilt for violating a criminal statute. Individual Ethics refers to those basic values, norms, beliefs, and practices that identify an individual and defines the way (s)he performs tasks. Code of Ethics refers to the company or engineering society's ethics codes – for example, ASME, IEEE, ASCE. PE License refers to the state licensure and regulation to practice engineering. Law refers to state and federal laws, both common law and statutory. Coworker Review refers to the day to day activity and interface with fellow workers. Peer Review refers to the means by which a Code of Ethics is utilized or enforced. Administrative Review refers to the State Board of Engineering's enforcement of its rules and regulations. Trial refers to the non-voluntary enforcement of state or federal, civil or criminal laws. An analysis of the various parameters effecting the Level of Ethics axis and the Accountability axis makes certain assumptions. Perhaps the most important assumption is that law itself is presumed to be ethical. It is debatable whether law is ethical on the issues of abortion, death penalty, and whether not to "pull the plug" and end a life, to name a few debatable issues of law. Philosophically, there could be a religious foundation for ethics that is higher than legislated law with accountability on the day of judgment that transcends any scale of engineering ethics.

The "Brant Scale of Engineering Ethics" is included to illustrate that as we progress as engineers, our level of accountability increases and our measured level of ethics also increases. That is not to say our ethics should increase, it is just our accountability for our ethics increases as we approach higher responsibility levels.

10.0 HOW DO YOU SOLVE ETHICAL DILEMMAS?

Again, from our working definitions, a dilemma is a forced choice between two or more choices that are equally bad.

In order to solve ethical dilemmas, there are three steps:

1. **First, you must recognize what causes ethical dilemmas.**

2. **Second, recall your Core Ethical Values and the "Golden Rule" and be willing to follow them.**

3. **Third, consult your company and/or discipline Code of Ethics.**

How do you recognize what causes ethical dilemmas? John C. Maxwell in his book, *There's No Such Thing As "Business" Ethics---There's Only ONE RULE For Making Decisions,* says there are five factors that most often come into play when someone compromises her/his ethics.

Maxwell's five factors are the five precursors of ethical violations or just the 5P's for short. The 5P's are predictors or warnings that alert us that ethical violations may be near.

What are the 5P's?

1. PRESSURE

Pressure comes in many forms. It can, and nearly always, involves money, either your money or the company's money. Money pressure is with you twenty-four hours a day, seven days a week. Pressure can also come in the form of performance, to do more, yourself, your department, your company. Sometimes schedule puts pressure on

engineers. Often there is pressure to just not tell the truth. These pressures, and the list is not all inclusive, cause breaches of ethics.

2. PLEASURE

Pleasure can be anything from adultery, to drinking, to drugs, to gambling, or anything in excess as Aristotle would view it. It is the "if it feels good, do it attitude" that will get you in trouble. Maxwell gives two ways to answer the pull of pleasure. The first key "is to run from temptation." He advises if you are susceptible to pleasure "that would tempt you to cross an ethical line, put yourself out of harm's way," avoid the temptation. Maxwell's "second key is to develop discipline." He says, "It's ironic, but to gain freedom, you need to contain your emotions with discipline. That takes character." Character and credibility go hand in glove. Once you have lost your credibility, you have lost yourself.

3. POWER

Here we are talking about the misuse or abuse of power. There is the worn-out phrase or cliché, "power corrupts, absolute power corrupts absolutely," but it is true. Maxwell reveals that "having power is like drinking salt water. The more you drink, the thirstier you get." It takes a special character to handle power well. The United States of America was founded on the principle that power would be divided between the three branches of government, judicial, executive, and legislative, and that no one man would hold all the power of the country.

4. PRIDE

Pride can be misinterpreted. When I played football and baseball in high school, we had pride in our uniforms, shoes were shined, and helmets were polished before every game. We had pride in our appearance. The military has pride in its appearance. I am not talking about that sense of pride. The dangerous pride is an exaggerated sense of self-worth to the detriment of others. It is the bigger house, better car attitude that gets people into trouble as well as into ethical violations.

5. PRIORITIES

A dictionary definition of priorities is a thing that is regarded as more important than another thing. However, that is not the way things often work. The thing demanding the most attention usually goes first.

Maxwell quotes Goethe, "Things that matter most must never be at the mercy of things that matter least." The question is what really matters to you? Once you have determined those things that really matter, you need to work at living them day by day.

The 5P's give a method of predictability of what is beginning to happen in an ethical sense. If you keep the 5P's in mind you are on your way to avoiding ethical dilemmas.

The first step in ethical dilemma solving is to learn and recognize the 5P's, then go to the second step of using your core values---Integrity, Honesty, Fidelity, Charity, Responsibility, and Self-discipline---and the Golden Rule, "do to others as you would have them do to you." Lastly, the third step, go to your company and/or discipline ethics code.

Most engineering disciplines have ethics codes. Different disciplines have ethics codes for example, Electrical Engineering-IEEE, Civil-ASCE, Mechanical-ASME; computer practitioners have the Software Engineering Code of Ethics and Professional Practice, the Association for Computing Machinery's Code of Ethics and Professional Conduct, the Australian Computer Society's Code of Ethics, the British Computer Society's Code of Conduct, and the Institute for the Management of Information Systems Code of Ethics; the Accreditation Board for Engineering and Technology (ABET) Code of Ethics; and numerous others.

Perhaps the most universal ethics code for engineering is the National Society of Professional Engineers' Code of Ethics for Engineers (NSPE) found at www.nspe.org/ethics/ . This code has also been translated into Spanish, French and German. The NSPE Ethics Code has some of the same requirements as state codes, which have the force of law behind them. The NSPE Ethics Code requires that safety, health, and welfare of the public shall be paramount; engineers should perform only in their areas of competence; shall be truthful; and shall be faithful agents or trustees. Many state codes of conduct have the same requirements.

WHAT DO YOU DO WHEN YOU HAVE THE ETHICS CODE?

As you might expect, opinions differ widely. It seems most authors of Engineering Ethics textbooks have a version of how to solve engineering ethical problems. I am not an exception.

Consider this; by and large most engineers would rather solve problems that are solvable with a high degree of certainty. Unfortunately, many ethics problems are *not* solvable with any degree of certainty. I believe that uncertainty contributes to ethical dilemmas being ignored. Moreover, ethical dilemmas lend themselves to opinions rather than analysis. Numerous ethical dilemmas do not lend themselves to a certainty and finality, or at least not immediate, solution.

I believe, and I think most of you will agree, "an ounce of prevention is worth a pound of cure." The 5P's are vital to assessing the situation before it develops. Your core ethical values and the Golden Rule allow you to make personal ethical assessments and solve many ethical problems. In actuality, you have been making ethical assessments and solving ethical problems most of your life. We just do not think of it this way. So, the equipment is there, it just needs to be focused. And, of course, there must be the will to have moral courage.

Once we get to the ethical code stage, and certainly at the legal stage, the situation changes. Instead of the 5P's, core values and Golden Rule, we are in regulatory or legal mode. Codes act as regulatory requirements that have some force and effect. The method for solving the code dilemmas becomes, in a sense, legalistic and necessitates a legal analysis.

HOW DO YOU DO A LEGAL ANALYSIS?

A legal analysis explores the facts, poses the issue or question to be answered, determines the law or basis to be applied to the problem, and then reasons the result or answer. It sounds simple, but it can be difficult in complex situations.

What are facts? Facts are actions, events, or circumstances that have actually occurred. Judge Herbert Stern in a lecture I attended, said the definition of "facts are what the jury believes at the end of the trial." Sometimes witnesses see the same event differently, like two children fighting, both have a different side to the story. Facts can be disputed, but for our purposes, facts are the relevant facts, largely undisputed

and set the foundation for the dilemma we are facing. Relevant facts are those facts that apply to the matter in question.

What is an issue? An issue is the disputed question or problem and can be characterized by having two or more sides to the dispute. It is usually phrased, "Whether this or that" and there can be more than one issue.

What is the law or basis? The law or basis to be applied to the issue is likely a section of the ethics code or law, but could be core values or the Golden Rule as the basis to be applied to the issue.

What is the result or answer? The result or answer is the reasoning that applies the law or basis to the issue to achieve a resolution.

You will notice that I have not mentioned in the steps to solving ethical dilemmas going to the law of your jurisdiction. If you have dutifully gone through the three step process and have not solved your ethical dilemma, it would be wise to seek legal counsel for your dilemma. Laws vary from state to state and certainly from country to country. Legal counsel within your jurisdiction may be a wise choice.

11.0 CAN'T I JUST GO TO AN ETHICS CODE?

I firmly believe that if you do not have personal ethics, no ethics code will be of any value. Every football coach knows that the way to success depends upon fundamentals, blocking and tackling. Personal ethics are the fundamentals of a Society, even if it is a Society of one.

Ronald J. Alsop author of *The 18 Immutable Laws of Corporate Reputation---Creating, Protecting, and Repairing Your Most Valuable Asset,* in Chapter 4: Live Your Values And Ethics, provides examples of ethics codes of companies. Johnson & Johnson uses an ethics code developed by their founder. J & J's Credo is on display in 56 countries in 36 languages on walls and tabletops. But, every two years the employees rate the company on how well it has lived up to the Credo and managers have "Credo Challenge" meetings and "Living our Credo

Values" sessions. The Credo is permeated throughout the company. J & J's Credo is 25 *lines* long, but it is followed, in spirit and intent.

Contrast, the 25 lines of J & J's Credo with the extensive 64 pages of the ethics code and set values: "respect, integrity, communication and excellence" of another company. The 64 pages of ethics code is a joke, because it belonged to Enron. Enron's ethics code says, "We want to be proud of Enron and to know that it enjoys a reputation for fairness and honesty and that it is respected….Let's keep that reputation high." The code is laughable when you consider the actions of Enron. (To see a copy, go to www.thesmokinggun.com)

Obviously, some of the folks at Enron were lacking in personal ethics and their code was meaningless. In order for an ethics code to work, the hearts and minds of the people applying the code must be grounded in personal ethics.

Another example of the point I am trying to get across, Brian Burrell author of *THE WORDS WE LIVE BY---The Creeds, Mottoes, And Pledges That Have Shaped America* in his chapter, Codes Of Ethics And Conduct, provides "The Code Of Baseball." Burrell tells us that major league baseball has the American and National leagues, each with its code of law or constitution that set out the rules of the game as to how the game is played and enforced. But, there is another tier of rules that are implied, dealing with etiquette or decorum.

Burrell argues that what makes baseball, "more than simply a game, is the fact that sports has always served as a teaching laboratory for ethics. As children play and emulate their sports heroes they absorb lessons that reflect the unwritten rules of the game, which constitute baseball's, or any sport's, true code of ethics. This is the code that coaches and veteran players pass along to rookies. It covers such matters as pitching inside, running out pop flies, and the decorum of the home run trot."

Burrell exemplifies a baseball code violation, when, "Deion Sanders, as a rookie, encountered this code when he declined to run out an infield popup. Out of indignation [for the game of baseball], the opposing catcher---the venerable Carlton Fisk---almost took Sanders apart. None of Sanders's teammates came to his defense."

"A true ethical code, like the code of baseball ethics, is an unspoken arrangement that loses its moral foundation as soon as someone tries to turn it into a set of laws. Instead, it reveals itself in the course of 'playing the game' (which is itself an expression that connotes living up to a high standard of behavior). When fans see the written regulations of the game enforced they are not seeing ethics at work. When they see major league players observing the rules of the game, the terms of their contracts, and the etiquette laid down by the league constitutions, they are not witnessing moral choices. Yet moral choices must still be made. Should a manager allow his team to run up the score in a lopsided game? Should a hitting champ sit out the last game of the season to protect his batting average?... The range of situations addressed by these questions cannot be entirely anticipated and codified. Yet it is through these choices that athletes…demonstrate their character, or what is sometimes called their heart."

"*The example of baseball also shows that a written code can only approximate what an unwritten code can do. Because an unwritten code functions within a consensus of understanding, it represents a shared imperative to uphold certain agreed-upon standards. Where there is no such consensus, where some individuals feel that they are above the code, or where there are simply too many individuals who are oblivious to the difference between right and wrong, a written code is the only alternative (emphasis mine)."*

Personal ethics is that unwritten rule, like baseball, by which you will be judged by others. How you play the game of life, will be marked by your ethics!

I would be remiss in not discussing the useful functions of ethical codes. Some of the useful functions are:

1. Codes can be used to educate new people in an organization by providing guidelines of ethical responsibility based on past experience and continuing development of the code and introducing them to ethical problems peculiar to the organization or discipline.

2. Codes can bracket areas of uncertainty.

3. Codes may help prevent government regulation which can cause loss of productivity.

4. Codes can provide a basis or foundation to build upon. (Johnson & Johnson's code was written by its founder over 70 years ago, but was updated in 1979 to include "protecting the environment and natural resources" and again in 1987 to add employees' family responsibilities.)

5. Codes can describe the characteristics required of professionals.

6. Codes can describe employee's obligations to the company and the company's obligations to its employees.

7. Codes can emphasize the obeisance of law and regulations.

Ethics codes are helpful because they set out the rules and how the rules are enforced. But, they do not set out the unspoken true moral foundation, character, or credibility of a person or organization.

12.0 GLOBAL ETHICS

Ethicist Peter Singer author of *One World---the Ethics of Globalization* illustrates globalization with two very different disasters. Planes flown into the New York Twin Towers on September 11, 2001, contrasted with carbon dioxide emissions from the exhaust of gas-guzzling sport utility vehicles. Globalization shows how people from far across the globe can come into the United States of America, destroy huge buildings, and kill thousands of people. And, that can happen almost anywhere on the globe. Globalization also allows the effects of gas-guzzling cars to cause climate changes across the globe in places like Mozambique or Bangladesh causing crops to fail, sea levels to rise, and tropical diseases to spread.

What is Globalization? Tom Friedman in his book, *The Lexus and the Olive Tree---Understanding Globalization,* defines globalization as "the inexorable integration of markets, nation-states and technologies to a degree never witnessed before—in a way that is enabling individuals, corporations and nation-states to reach around the world farther, faster, deeper and cheaper than ever before, and in a way that is enabling the world to reach into individuals, corporations and nation-states farther, faster, deeper, cheaper than ever before."

He opines the mechanism behind Globalization is the free-market capitalism that allows free trade between almost every country on the globe. He calls globalization not just an economic system, but the

***dominant international economic system*, essentially a system that knows no boundaries.**

In this new world economy, innovation replaces tradition. What is here now, will be overtaken and replaced with what will come next. The old cold war era was a world of friends on one side and enemies on the other, and we knew who they were. The globalization world will make competitors out of friend and foe alike.

While globalization demands innovation, it makes for a difficult place for humans to live. Most people try to live with certainty in their lives, job, house, family, friends, and some sense of security around them. Unfortunately, the globalized life is nothing but uncertainty. Primarily, the uncertainty of jobs, here today, outsourced tomorrow.

Interestingly, globalization does not require us to keep our relationships with those around us, but that is what is needed to prosper in the global economy. Of course, when we are talking about relationships, we are talking about ethics; when we are talking about global relationships, we are talking about global ethics.

To understand globalization, and global ethics, we must understand the mechanism of what is causing the effect. Here, Friedman demonstrates, "the traditional boundaries between politics, culture, technology, finance, national security and ecology are disappearing. You often cannot explain one without referring to the others, and you cannot explain the whole without reference to them all." You have to learn information from each of the "disparate perspectives" and weave that information together to obtain a total picture of what is happening, even from your little corner of the world. Unfortunately, many of us have become specialists in a particular field and have a myopic view of others in the world, completely unknown today, but with whom we will be doing business tomorrow.

Regarding personal relationships, Friedman adds, "You cannot be a complete person alone. You can be a rich person alone. You can be a smart person alone. But you cannot be a complete person alone."

Friedman tells a story, which I will edit slightly and call the, "Complete Person." Once upon a time there was a village, where people were

plagued with forgetfulness, which was contagious. Starting with the elderly, forgetfulness spread. One enterprising young man had an idea. He would put a label on things, i.e., this is a table, this is a cow and has to be milked every morning. To the entrance of the town, he put up a sign that read, "This is our village Macondo," and another larger sign that says, "God exists."

Friedman explains what that story means to him; that we will "forget most of what we have learned in life---the math, the history, the chemical formulas, the address and phone number of the first house we lived in when we got married---and all that forgetting will do us no harm. But if we forget whom we belong to, and if we forget that there is a God, [or our ethics] something profoundly human in us will be lost."

Let us look specifically at global ethics. Peter Singer asserts that our new found global society, linking people together, "gives us a material basis for a new ethic." If we go around acting like a tribe, then our morality will be tribal. But, the globalized revolution "has created a global audience, and we might feel a need to justify our behavior to the whole world [to share trade, if nothing else]. This change creates the material basis for a new ethic that will serve the interests of all those who live on this planet in a way that, despite much rhetoric, no previous ethic has ever done."

Therefore, how well we come through the globalization era, will depend upon how we think, act, and be ethical to the idea that we all live in one world. And, this world is no longer very large. If the rich nations of this world do not take the ethical high road, their security will be in danger in the long term.

Global ethics is good for us, good for them, and is required to live on this planet. The sooner we learn this, the better off we will be---and, happier.

13.0 WHAT ARE SOME ENGINEERING ETHICS EXAMPLES?

FORD PINTO CASE

If you remember our graph of Good and Evil, the most egregious example of evil in an engineering sense, I can think of, is the Case of the Ford Pinto, a product of the Ford Motor Company (photo below).

The facts of this case come from the appellate opinion in *Grimshaw vs. Ford Motor Company, 119 Cal.App.3d 757, 174 Cal.Rptr. 348 (1981).*

"On May 28, 1972, Mrs. Gray, accompanied by 13-year-old Richard Grimshaw, set out in the Pinto from Anaheim for Barstow…The Pinto was then six months old…the Pinto suddenly stalled and coasted to a halt in the middle lane…but the driver of a 1962 Ford Galaxie was unable to avoid colliding with the Pinto….before the impact had been braked to a speed of from 28 to 37 miles per hour."

"At the moment of impact, the Pinto caught fire and its interior was engulfed in flames….the impact of the Galaxie had driven the Pinto's gas tank forward and caused it to be punctured by the flange or one of the bolts on the differential housing so that fuel sprayed from the punctured tank and entered the passenger compartment through gaps resulting from the separation of the rear wheel well sections from the floor pan. By the time the Pinto came to rest after the collision, both occupants had sustained serious burns….Mrs. Gray died a few days later…Grimshaw managed to survive but only through heroic medical measures. He has undergone numerous and extensive surgeries and skin grafts and must undergo additional surgeries over the next 10 years…"

"Design of the Pinto Fuel System:

In 1968, Ford began designing a new subcompact automobile…Mr. Iacocca, then a Ford Vice President, conceived the project and was its moving force. Ford's objective was to build a car at or below 2,000 pounds to sell for no more than $2,000.

Ordinarily, marketing surveys and preliminary engineering studies precede the styling of a new automobile line. Pinto, however, was a rush project…Among the engineering decisions dictated by styling was the placement of the fuel tank…placed behind the rear axle leaving only 9 or 10 inches of 'crush space' far less than in any other American automobile or Ford overseas subcompact. In addition, the Pinto was designed so that its bumper was little more than a chrome strip…The absence of the reinforcing members rendered the Pinto less crush resistant than other vehicles. Finally, the differential housing selected for the Pinto had an exposed flange and a line of exposed bolt heads. These protrusions were sufficient to puncture a gas tank driven forward against the differential upon rear impact."

"Crash Tests:

During the development of the Pinto, prototypes were built and tested….prototypes as well as two production Pintos were crash tested by Ford to determine, among other things, the integrity of the fuel system in rear-end accidents….The crash tests revealed that the Pinto's fuel system as designed could not meet the 20-mile-per-hour proposed standard…"

"The Cost To Remedy Design Deficiencies:

When a prototype failed the fuel system integrity test, the standard of care for engineers in the industry was to redesign and retest it. The vulnerability of the production Pinto's fuel tank at speeds of 20 and 30-miles-per-hour fixed barrier tests could have been remedied by inexpensive 'fixes,' but Ford produced and sold the Pinto to the public without doing anything to remedy the defects…"

"Management's Decision To Go Forward With Knowledge Of Defects: …

[T]he engineers responsible for the components of the project 'signed off' to their immediate supervisors who in turn 'signed off' to their superiors and so on up the chain of command until the entire project was approved for public release by Vice Presidents Alexander and MacDonald and ultimately by Mr. Iacocca. The Pinto crash tests results had been forwarded up the chain of command to the ultimate decision-makers and were known to the Ford officials who decided to go forward with production."

From the text, *Engineering Ethics: Concepts and Cases,* Harris, Pritchard, and Rabins, "[F]ord contended that the Pinto met all applicable federal safety standards at the time. J. C. Echold, director of automotive safety for Ford, issued a study entitled 'Fatalities Associated with Crash Induced Fuel Leakage and Fires.' This study claimed that the costs of improving the design ($11 per vehicle) outweighed its social benefits. A memorandum attached to the report described the costs and benefits in this way:

Benefits	
Savings	**180 burn deaths, 180 serious burn injuries, 2100 burned vehicles**
Unit cost	**$200,000 per death, $67,000 per injury, $700 per Vehicle**
Total benefits	**180 x $200,000**
	180 x $67,000
	2100 x $700 = $49.5 million
Costs	
Sales	**11 million cars, 1.5 million light trucks**
Unit cost	**$11 per car, $11 per truck**
Total costs	**11,000,000 x $11 plus**
	1,500,000 x $11 = $137 million

The estimate of the number of deaths, injuries, and damage to vehicles was based on statistical studies. The $200,000 for the loss of a human life was based on a National Highway Traffic Safety Administration study, which estimated social costs of a death in this way:

Component	***1971 Costs***
Future productivity losses	

Direct	**$132,000**
Indirect	**41,300**
Medical costs	
Hospital	**700**
Other	**425**
Property damage	**1,500**
Insurance administration	**4,700**
Legal and court	**3,000**
Employer losses	**1,000**
Victim's pain and suffering	**10,000**
Funeral	**900**
Assets (lost consumption)	**5,000**
Miscellaneous accident cost	**200**
Total per fatality	**$200,725"**

"On January 15, 1980, the Ford Motor Company went on trial on charges of reckless homicide in the 1978 death of three Indiana teenagers who burned to death after their 1973 Ford Pinto was hit from behind by a van. Indiana state prosecutors alleged that Ford knew Pinto gasoline tanks were prone to catch fire during rear-end collisions but failed to warn the public or fix the problem out of concern for profits. The trial marked the first time that an American corporation was prosecuted on criminal charges." (www.historychannel.com/speeches/archive/speech_465.html)

SOLVING THE ENGINEERING ETHICS DILEMMA

Do we have a dilemma based upon the facts of this case? Yes. Let's analyze this situation. First, look at the 5P's, Pressure, Pleasure, Power, Pride, and Priorities. Was there pressure? Yes, money, had to be sold at $2000. Performance pressure? Yes, had to be built at 2000 pounds. Schedule pressure? Yes, was a rush project.

Was there a pleasure problem? Not likely. How about a power problem? Probably, Mr. Iaccoca conceived the project and was its moving force. It would appear nothing was going to stop his project. Pride was apparent. Ford's executives wanted the Pinto in the market, it appeared their pride overruled safety. How about

priorities? Common sense would dictate that the car should be safe and people not necessarily injured by the design of the car.

So, the 5P's would have alerted us, if we were in Ford's shoes, that there was an engineering ethical problem before the Pinto was sold to the public.

SECOND STEP

Did Ford violate any core ethical values or the Golden Rule? Remember our core ethical values---Integrity, Honesty, Fidelity, Charity, Responsibility, and Self Discipline. I would say Ford violated every one of the core ethical values. Integrity, Ford failed to exercise good judgment or ethical principles. Honesty, Ford was not truthful. Fidelity, Ford had no faithfulness to its clients who depended on Ford to build a reasonably safe car. Charity, Ford had no kindness, caring or good will to its customers or public. Responsibility, Ford, prior to the court cases, had no accountability or trustworthiness. Self Discipline, Ford was acting in an excessive behavior from the outset of the project and not only did not act with reasonable restraint, it did not even act with caution.

Ford violated every core ethical value. How about the Golden Rule? Ford violated the do to others, as you would have them do to you. One has to wonder if the design would have been different, if those approving the design had to drive the Pinto or someone in their family.

LAST STEP
Facts
The relevant facts in the Grimshaw case and the Indiana case are that Ford Motor Company designed, manufactured, and sold to the consuming public the Pinto automobile. The Pinto was rushed to production. The style of the car was allowed to dictate engineering principles of where to locate the gas tank. Crash tests were performed, but the car did not adequately pass the tests. There were known engineering design fixes that were relatively inexpensive. With knowledge of the inadequate design and knowledge of the inexpensive design fixes, Ford knowingly sold the Pinto to the public. Theses facts were known before production and sale. At some point

in time, Ford in its study of "Fatalities Associated with Crash Induced Fuel Leakage and Fires" performed a cost/benefit analysis and decided it was cheaper (more profitable for Ford) to allow people to burned to death and suffer severe burn injuries.

ISSUE

Did Ford Motor Company violate either its company ethics code or discipline ethics code? Did Ford violate any state or federal law?

RULE

Several rules could apply in this case. I have been unable to locate a Ford Motor Company Code of Ethics at the time of the Pinto. Presently, Ford has corporate governance guidelines, but no corporate Engineering Code of Ethics as such could be found on Ford's website, www.ford.com . Ford does have a Code of Ethics for Senior Finance Personal and Board of Directors, however.

The American Society of Mechanical Engineers (ASME), now ASME International, www.asme.org has had a code of ethics since 1913.

Virtually all ethics codes hold the health and safety of the public is paramount.

RESULT

Ford violated the key ethical principle of holding the health and safety of the public paramount. On every ethical analysis level, Ford Motor Company failed in its design, production, and sale of the Pinto. Ford Motor Company also violated the civil law in the Grimshaw case and others. Ford was acquitted in the Indiana criminal case.

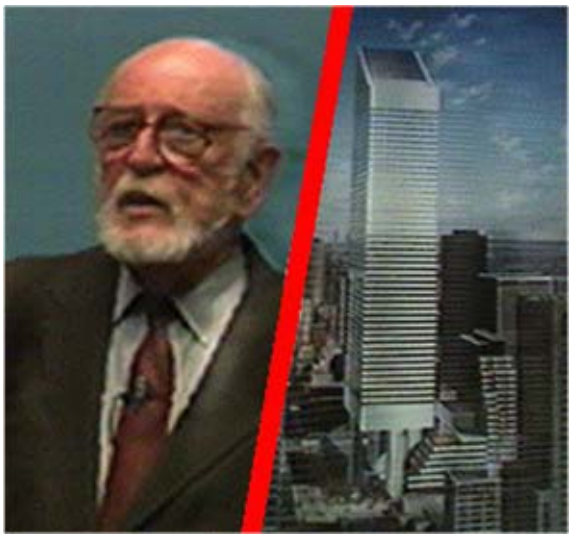
CITICORP BUILDING CASE

St. Peter's Lutheran Church, since 1862, stood at 54th Street and Lexington Avenue in Midtown Manhattan. St. Peter's covered 30% of the block where developers wanted to build the Citicorp Tower.

The church agreed to sell portions of the property if a new church would be built with free sky overhead and if a plaza under the tower continued the church's tradition of hospitality. To meet the church's demands an innovative approach had to be taken. The Citicorp Tower would be constructed overtop of the new church, some ten stories above the church on 17.5 foot columns and a central core.

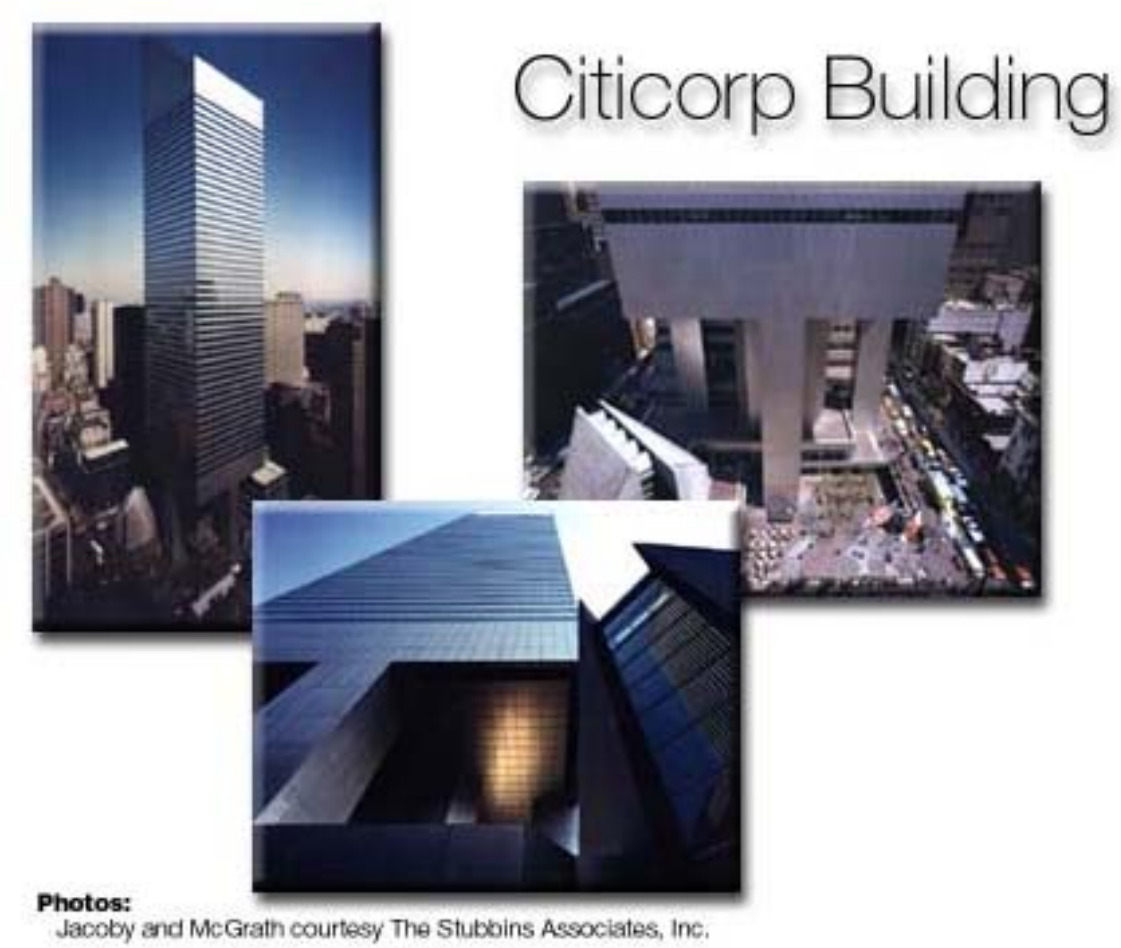
The novel approach put the columns, not at the corners of the building, but at the center of each side of the building. The area underneath the tenth floor was to be used as leisure space for workers and pedestrians.

The structural engineer on the Citicorp Tower was William LeMessurier of LeMessurier Consultants (photo below).



Half the gravity and all the wind loading is through the trussed frame on the outside of the building with the core carrying the remaining gravity loads. LeMessurier used a diagonal bracing design transferring weight to the columns and added a tuned mass damper to reduce wind sway of the building. The tuned mass damper consisted of a 400-ton concrete block that counteracts swaying.

The Citicorp Tower was completed in 1977, was ranked tenth in the world's tallest buildings, and stood 915 feet high. (Notice the columns and core of the Citicorp Tower shown below.)



After the building was completed, LeMessurier had a call from a student whose professor believed the columns should have been on the corners for loading. He told the student his professor did not understand the design problem and that the design would be more resistant to quartering or diagonal wind loadings.

New York City building codes did not require diagonal wind loadings. The building codes only required 90 degree wind loadings and the Citicorp Tower met those codes.

LeMessurier reviewed the design again and performed new calculations under different wind conditions. His new calculations resulted in loading conditions under some wind conditions to be 40% higher than what he had originally calculated. While LeMessurier was consulting on an out of town project, he called his home office to obtain cost data on full penetration welds on girders designed like the Citicorp Tower. Instead of obtaining the cost data, he found out that the girders at Citicorp Tower had been bolted, differing from the design specifications.

Now, LeMessurier was faced with a structure than had not followed specifications and his new calculations were 40% higher. Could the Citicorp Tower withstand higher and diagonal winds? Checking meteorological records revealed New York City could expect a storm every 16 years that would over load the structure.

Here was a perfectly legal building meeting all required codes. What should LeMessurier do?

LeMessurier did not wait. He developed a plan to weld two inch steel plates over the 200 or so joints. He met with his insurance company and the project's architect. Then they began meeting with Citicorp. Citicorp was supportive of the fix. Next, they met with the city building inspectors who approved the plan. Meetings were held with city disaster agencies in the event a mass evacuation of the building was necessary.

Fortunately, the New York newspapers went on strike and the repairs were finished by the time the strike was over. Hence, no media scare.

LeMessurier faced financial ruin and he knew this when he formulated his plan. However, Citicorp settled for LeMessurier's errors and omissions insurance policy of $2 million.

SOLVING THE ENGINEERING ETHICS DILEMMA

FIRST STEP

Look at the 5P's. Pressure? Yes, pressure from the cost to repair and schedule pressure. Pleasure? Pleasure was not a precursor in this situation. Power? Again, not a factor. Pride? Pride would have said, "I met all the codes and that is all I have to do." The reverse of pride took place. It was a humbling experience to admit costly mistakes were made and to own up to them. Priorities? LeMessurier held safety as the highest priority, and his ethics above legal limits and building codes.

SECOND STEP

Go to the Core Ethical Values. Integrity? LeMessurier acted with utmost adherence to ethical principles and judgment in the practice of engineering. Honesty? LeMessurier acted with truthfulness and openness. Fidelity? LeMessurier acted with faithfulness to his client and the public. Charity? Yes, caring and good will in action. Responsibility? LeMessurier's actions demonstrated his reliability, accountability, and trustworthiness. Self Discipline? LeMessurier was self disciplined to see past his own financial ruin to do what was in the best interest to his client and the public.

The Golden Rule? The Golden Rule must have been William LeMessurier's motto because he certainly followed it.

THIRD STEP

Refer to the Code of Ethics for your company and discipline. William LeMessurier held the health and safety paramount which is what is required by virtually all ethics codes.

Mistakes will be made, but you should have the "moral courage" to come forth ethically. William LeMessurier had "moral courage" and makes us feel good by his example.

SPACE SHUTTLE COLUMBIA CASE

Launch of Space Shuttle Columbia was on January 16, 2003 (below).

What a magnificent sight as Columbia roars into space!

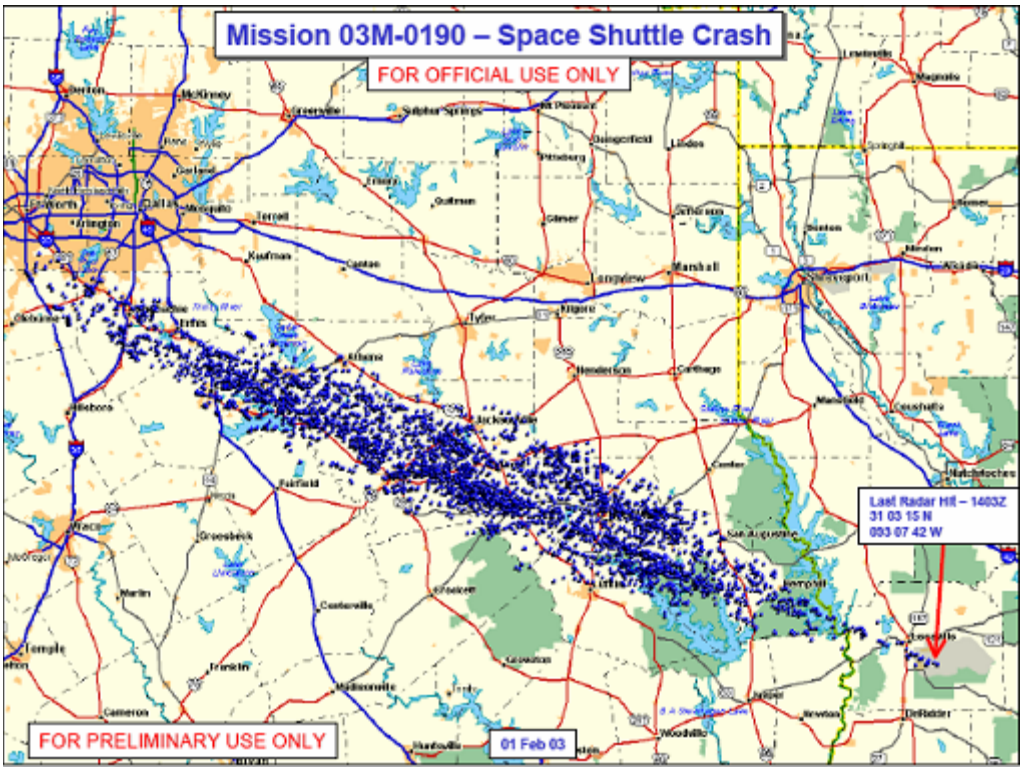
Columbia flew the first space shuttle mission (STS-1) on April 12, 1981. Now, after a successful mission, STS-107 was headed home after 16 days on February 1, 2003.

The crew of Columbia (figure above, from left to right, Brown, Husband, Clark, Chawla, Anderson, McCool, and Ramon) after sixteen days in space were just sixteen minutes from home.

It was 8:15 a.m. EST when Columbia's rocket brakes fired and the ship dropped out of earth orbit on its way to Kennedy Space Center for landing and celebration.

Streaking toward home, Columbia was traveling about 5 miles per second. Columbia's commander, Rick Husband attempted to reply to Houston Mission Control, "Roger, uh, buh…" and was cut off. Mission Control attempted to contact Columbia, "Columbia, Houston, comm check." No reply from Columbia, and the sensor data stopped. "I think we've lost them."

Indeed, Columbia and its crew were lost, as the debris field scattered from the Fort Worth, Texas area to Louisiana shows in the figure below.



The Columbia tragedy became more personal to me, when Dr. James Walker of Southwest Research Institute, San Antonio, Texas, gave a presentation of his findings to our local engineering societies on what caused the Columbia to self –destruct.

Dr. Walker and Southwest Research were tasked with studying the impact of the insulating foam that came off the left bipod ramp on the external tank and struck the orbiter during launch. Initially, the bulk of the data was from the wheel well around the landing gear.

Dr. Walker developed equations for the impact analysis. He determined that the wheel well area could not be the vital impact area that caused the crash of the Columbia. The team studied various angles and refined the equations. After developing the equations and analyzing the impact, Dr. Walker and the team determined that the analysis was showing them that the leading edge

of the orbiter was hit between two tiles that made up the heat shield, called Reinforced Carbon-Carbon (RCC) panels on the Thermal Protection System. They further calculated that the foam struck the leading edge in the neighborhood of 525 miles per hour (delta V). The RCC panels were very fragile and susceptible to damage.

After the analysis was performed, Dr. Walker and the group obtained a wing off of another space shuttle that was in the Smithsonian Museum. Southwest Research has a compressed nitrogen cannon that can be set up to duplicate the calculated parameters of impact. The physics of the foam projectile was substantiated by the Southwest Research team firing a piece of foam into the Smithsonian Museum shuttle wing at the precise angle.

Once the RCC panels were damaged on the Columbia, the hot plasma gases on re-entry cut the wing off the Columbia, like a cutting torch, causing it to break up.

WHY DID COLUMBIA CRASH?

The simple technical answer is that the Space Shuttle Specifications were not followed. Specifically, two specifications directed at not allowing debris:
"3.2.1.2.1.4 *Debris Prevention:* The Space Shuttle system, including the ground systems, shall be designed to preclude the shedding of ice and/or other debris from the Shuttle elements during prelaunch and flight operations that would jeopardize the flight crew, vehicle, mission success, or would adversely impact turnaround operations.
3.3.2.1.1.17 *External Tank Debris Limits:* No debris shall emanate from the critical zone of the External Tank on the launch pad or during ascent except for such material which may result from normal thermal protection system recession due to ascent heating."

Theoretically, the problem could be solved by requiring the specifications to be followed. However, the overarching question is why the specifications were not followed and what other specifications were not followed.

NASA had a habit of flying with a large number of "safety waivers." Columbia was launched with more than 1600 "safety waivers," or known problems, that had the potential to destroy the shuttle and kill the crew. NASA continued to use this running list of space shuttle components that were not working correctly or deviating from specifications.

AN ENGINEERING ETHICAL DILEMMA

Many of the complexities in the analysis of the Space Shuttle Columbia tragedy are beyond the scope of this course. The NASA space shuttle program is one of the most complex engineering feats in the history of mankind. Nevertheless, Columbia presents a tremendous learning tool.

With this background, let us look at one of the engineering ethical dilemmas presented by Columbia, the "safety waiver." NASA's "safety waivers" put engineers in an ethical dilemma, the choice between two or more evils.

Each "safety waiver" requires engineers to either (1) redesign the system to meet requirements, or (2) disregard the requirement. Because of the interdependency of systems and components on the space shuttle, the redesign of systems will lead to more cost and delay, as well as the potential to cause other systems to be less safe with the redesigned system in place.

However, to use "safety waivers" requires engineers to analyze the hazard and danger, and determine if the risk of failure is acceptable. "Acceptable Risk" is itself an ethical dilemma. The "safety waiver" analysis ends with written documents whose purpose is to convince managers that the shuttle is acceptable to fly as-is.

SOLVING THE ETHICS DILEMMA

FIRST STEP

Look at the 5P's. Pressure, Pleasure, Power, Pride, and Priorites. Were any of these precursors in play?

SECOND STEP

Go to the core values---Integrity, Honesty, Fidelity, Charity, Responsibility, Self Discipline---and the Golden Rule. Are these values and the Golden Rule applicable, and if so which ones?

THIRD STEP

Refer to the Code of Ethics for your company (NASA) and your discipline.

Apparently, NASA does not have an engineering code of ethics. Moreover, a 1997 Journal article entitled, "NASA and Ethics: Training and Practice," severely criticizes NASA and its approach to ethics:
"The results of the review of literature for this study and the initial contacts with NASA ethics officers indicate little regard for ethics at NASA. This means that NASA uses a low road, bureaucratic approach to what constitutes ethical behavior, with emphasis on financial conduct and risk management rather than upon morals and values….Worse it does not, in the eyes of many constitute a bonafide ethics program…
Officials need to think about deterring problems, as well as detecting or ignoring them. Discussion about ethics at NASA needs to permeate the agency and include citizens who can bring concern for the public interest, social equity, and personal interest into the bureaucratic milieu. NASA needs responsive and responsible decisionmakers who are able to define the ethical dimensions of a problem and to identify and respond to an ethic of public service as well as one of risk management. Where ethics at the space agency is concerned, to abide by the law is absolutely necessary, *but it is woefully insufficient* (emphasis mine)."

Unfortunately, since that ethics Journal article was written, ethics at NASA has not improved. Ironically, many states are requiring engineers to take engineering ethics and NASA, looked upon as an elite scientific and engineering organization, does not have an engineering ethics code.

Nevertheless, there are engineering ethics codes applicable, such as the National Society of Professional Engineers (NSPE) and engineering disciplines, for example, the ASME International (ASME). NSPE's Fundamental Canons states: "Engineers, in the fulfillment of their professional duties, shall: 1. Hold paramount the safety, health, and welfare of the public." Likewise, ASME in its Fundamental Canon states: "Engineers shall hold paramount the safety, health and welfare of the public in the performance of their profession duties."

Paramount is a key word. A dictionary definition for paramount is more important than anything else, supreme. Safety, health and welfare of the public are more important than anything else. Does the public include astronauts?

FACTS

The facts of this particular ethical dilemma are that there are some 1600 "safety waivers" on Columbia, and presumably other space shuttles. The "safety waivers" were justified on an acceptable risk basis. There was a long debris field that could present a hazard to the public. (There are many other factors that have impacted the Space Shuttle Program; organizational structure, culture, safety system, political, budgetary and the policy decision making process, to name a few, that contributed to the demise of Columbia.)

ISSUE

Whether or not "safety waivers" violate our ethics and/or the engineering ethics code? As a sub issue, whether or not the "safety waivers" present an acceptable risk? As another sub issue, whether or not the public is protected from the space shuttle?

LAW OR BASIS

The bases for our evaluation of the ethical dilemma presented by the facts above is the NSPE and ASME Code of Ethics for Engineers.

RESULT OR ANSWER

Coming to a result of answer is difficult in law and ethics. In law as in ethics, opinions differ on what the law is or what the proper ethical solution should be. Many times in the history of the United States, the United States Supreme Court has decided an issue by a five to four vote. That means that four very learned judges disagreed with the others on matters of law.

Using the NSPE and ASME Codes as the basis for our decision making, we know that the requirement that engineers shall hold safety, health and welfare of the public more important than anything else. We can review the other portions of the codes, but the safety, health, welfare is the most important requirement.

Holding safety, health and welfare of the public more important than anything else, we turn our attention to the "safety waivers." The 1600 plus "safety waivers" have a potential to destroy the shuttle and kill the crew. One question that must be determined is whether the crew is considered the public? If the crew is not the public, then there are two standards, one for the public and one for the crew. Is it ethical to have separate standards? Is it ethical to protect the public, but sacrifice the crew? Cultural differences may see the answer to this question as having two separate standards and the crew is not the public.

My personal belief is that the crew is part of the public, a group of the public, who should have the protection for safety and health more important than anything else, the paramount standard. Therefore, ethically we must consider each of the "safety waivers" as violating our "paramount standard."

Ethically, we could stop right there and say that all 1600 plus "safety waivers" having a potential to kill the crew should be fixed before exposing the crew as members of the public. This is highest ethical solution to the dilemma. Fix all "safety waivers" or do not fly the shuttle.

The sub issue addresses "acceptable risk" and whether the "safety waivers" constitute a risk willing to take. Think back to the questions testing "The Problem." Most people accept driving a car as an "acceptable risk," as well as flying in a commercial airliner. A

smaller group accepts the risk of riding a motorcycle. Simply put, there is risk in everyday life. There is "acceptable risk" in everyday life. The problem comes from deciding what measure of "acceptable risk" there should be. What is "acceptable risk" for me, may not be "acceptable risk" for you.

Diane Vaughan in her book, *The Challenger Launch Decision---Risky Technology, Culture, and Deviance At NASA* describes how the "acceptable risk" process worked at NASA. Vaughan explains: "The Acceptable Risk Process was the basis for all technical decision making at NASA, from daily decision making to the formalized, final decision process…Starting from the assumption that all shuttle components are risky, engineers had to determine whether the risk of each item was acceptable. 'Acceptable Risk' was a formal status conferred on a component by following a prescribed NASA procedure….It could be classified as an Acceptable Risk only on the basis of a documented engineering risk rationale…an analysis of the problem, the probability of its recurrence, and data supporting a conclusion of acceptable risk." Interestingly, prior to Columbia's first launch in 1981, the "acceptable risks" filled six volumes.

"Acceptable Risk" is discussed in Nancy G. Leveson's book, *SAFEWARE System Safety And Computers---A Guide to Preventing Accidents and Losses Caused by Technology.* She explains that in order to compare risks and benefits, there must be a measure of risk and an appropriate level for decision making. But, even if the risk can be accurately measured, there is still the problem of what level is acceptable. After explaining other approaches, Leveson confesses: "It appears that there are no entirely satisfactory methods for making these decisions. Part of the explanation for this lack of mathematical and engineering solutions is that the decisions involve deep philosophical and moral questions---not simply technical choices."

Unfortunately, we have come full circle, starting with philosophical and moral questions around to acceptable risk and philosophy and moral or ethical questions.

In my opinion, using the "paramount standard" of the codes, the 1600 plus "safety waivers" posed an unacceptable risk. Some may

argue that I do not have a clue as to what the "safety waivers" really are, and that is true, but the trend is in the wrong direction and safety is paramount. Might I think differently if I were an engineer at NASA? Possibly, so. However, life is the ultimate price to pay for poor design, and I believe it is best to error on the side of caution.

The sub issue of whether the public is protected from the space shuttle in the event of a mishap and complete destruction with parts falling to the ground needs attention. The public must be protected from a space shuttle mishap. One only has to study the debris field to conclude NASA was lucky that no one was killed on the ground from the breakup of the Columbia. Had Columbia started breaking up only moments earlier, over population centers, the result could have been much worse. No one was killed or injured on the ground by Columbia, but NASA may not be that lucky the next time. Ethically, Space Shuttle re-entry should be over sparsely populated areas or water to preclude injury to the public, in the event history repeats itself.

The three Engineering Ethics examples, Pinto, Citicorp Tower, and Columbia, provide an analysis for making ethical choices in real life situations. The important thing is to put yourself in these situations, vicariously, and determine how you would follow your ethics.

14.0 SUMMARY

Together, we have covered almost 2500 years of the philosophy of ethics in a nutshell. Along the way, we have self-assessed ourselves: "the unexamined life, is not worth living."

We have learned there is a common thread that ties religions and cultures together and are touchstones for a Global Society, that will require Global Ethics for cultures to co-exist on this planet. We have learned the forces applied to ethical situations. We have learned the 5P's or ethical precursors to predict ethical problems. We have learned the core ethical values. And, we have learned the legal analysis approach to solving ethical dilemmas.

We have studied examples of good and evil ethics to prepare us for our future challenges. We hope to be wiser.

Along the way, we have opened our hearts and minds to ethics, allowing us to make "The Right Choice: Applying Ethics to Engineering," and beyond.

The Right Choice: References, Acknowledgments & Websites

The Right Choice: Applying Ethics to Engineering started development in 2001. Since then, countless websites were visited, many with links to other sources, some of which are no longer on the air. I have tried to make every attempt to provide credit to those sources used in this course. Thanks to Tom Bivens, whose Course in Media Ethics at the University of Oregon, became the format for my Engineering Ethics lectures at the University of Texas at San Antonio.

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