



PDHonline Course R119 (2 PDH)

Classic Ethics and Engineering

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2012

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Classic Ethics and Engineering

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Course Content

The goal of this course is to address daily engineering decisions and help the design professional prepare a justification for his actions. The justification can be used as a guide for future, consistent decisions, as a guide for subordinates, and as a part of the project record for those who come after us.

narration	In the course of the following discussions, I have made an attempt to separate my personal conclusions from the range of conclusions available. To the extent possible, I will relate the actual decision and consequences. Narration boxes, like this one, will contain my personal comments.
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Before we address engineering decisions, however, we need to join the 2,500 year+ dialog on ethics. This lets us use the common terms and utilize the insights of our predecessors.

Meta-Ethics

Meta-ethics tries to identify truth and universal ethical principles which can be applied to specific situations. (<http://en.wikipedia.org/wiki/Ethics>) Both truth and universal ethical principles are very difficult to find.

One of the key points of meta-ethics is that many very real questions and resulting decisions do not fall within the realm of ethics. Art is the prime example. Choice of sculpture #1 or sculpture #2 has no significance beyond the totally personal sense of aesthetics.

In my first ethics course I did a paper on truth and identified 11 levels of truth, as follows:

- ___ absolute, universally true, all the time, everywhere, under all conditions (red is red)
- ___ used to be true but no longer - (rub butter on a burn, ice on frostbite)
- ___ known not to be true, but acknowledged none-the-less (Emperor's new clothes, Iraq and 9/11)
- ___ known to be true, but denied by persons in authority (Holocaust, earth round)
- ___ never was true, couldn't possibly be true, why do they keep saying it (I'm from the government, here to help you; I'll be right with you; we value your call.)
- ___ current best available technology; probably obsolete in 18-mo (Blu-Ray)
- ___ true here-and-now only; to be revised next place, next time (politicians)
- ___ best available description of the phenomenon; not offered as proof (orbital description of atoms)
- ___ documented word of an expert (James Watt wouldn't work on high pressure boilers)
- ___ consistent, repeatable results under controlled conditions (sex --> babies)

_____ absolute, universally false, all the time, everywhere, under all conditions (red is black)

The list is not numbered because I was never able to rank the levels of truth. It is clear, though, that there are multiple definitions of truth.

Note that statutory law, case law and civil law operate under a totally different concept of truth and are not addressed here.

The list of 11 types of truth is offered to demonstrate that almost all the time, the “facts” of a situation are severely filtered by the interests of the participants. The surprise is that, most of the time, the participants can agree on a set of facts as the basis of the work towards an acceptable decision.

This leads nicely into the quotation, presented earlier, from George Knepper, Professor of History (ret.), The University of Akron, Akron, OH

“There are a wide range of acceptable ethical decisions, but we must work from a single set of facts.”

Dr. Knepper was lamenting the propensity of young persons to aggressively take positions, though lacking experience or the reading of history.

Universal ethical principles also become very slippery on close inspection. For example, a recent bumper sticker said, “Respect all life.” This list is presented to demonstrate the conditional aspect of applying something that we agree with.

- Does this mean to not-use antibiotics to kill germs in your bloodstream? Those germs are alive.
- Does this mean to not-use chlorine to treat drinking water? Those e-coli germs are alive.
- Does this mean to wear a surgical mask to avoid inhaling microbes and bugs?
- Does this mean not to shoot a rabid dog?
- Does this mean not to slaughter cows for meat?
- Trees are alive. Does this mean we shouldn't eat vegetables either?
- Does this mean not to execute mass murderers?
- Does this mean not to offer \$25,000,000.00 for information on the location of someone and use the information to bomb his house and kill him?
- How does this relate to the US Government term “collateral damage” for people they kill while really trying to kill someone else?
- Does this mean to not drop two bombs and kill 400,000 Japanese?
- Is someone trying to twist things so that killing with respect is OK?

narration	What does this have to do with making ethical engineering decisions? The point is that it is not as easy as finding a good general principle and following it. The next section, Normative Ethics, tries to examine how a range of external and internal directives can be applied to specific questions / decisions.
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Normative Ethics

In this section, we will look at theory of conduct, theory of value and stakeholder interests. The first two topics closely follow the Wikipedia article.

One theory of conduct is consequentialism. This takes the form of “Do unto others as you would have done unto yourself” and “One ought to take action A if and only if A maximizes the amount of good”. I have paraphrased it for my children as, “Don’t do things that hurt the Kid.”

Consequentialism focuses on the desirability of the results. It recommends actions which produce favorable results. Two major problems exist, however. We don’t know the future, so any prediction has some value of probability associated with it. And, “good” is a very flexible word, almost as slippery as “truth”.

I use this guide for my children because it clearly implies value in the future over value in the present, though it never explicitly states it. Consequences of car wrecks and hang-overs are emphasized, the fun and fellowship of drinking are ignored.

Other theories of conduct are egotism and utilitarianism. It is clear that these are special cases of consequentialism. Egotism defines “good” as “personal good”, and utilitarianism defines “good” as “pleasure, happiness, or eudaimonia of as many people as possible”.
(http://www.orientalia.org/wisdom/Philosophy/Theory_of_conduct.shtml)

The problems with probability and “good” lead into the discussion of theory of value.

A very early theory of value postulated that pleasure is good and pain is bad. This concept has been accepted and rejected by philosophers through history. (See Socrates, Plato, Aristotle and John Stuart Mill.) (<http://plato.stanford.edu/entries/value-intrinsic-extrinsic/>)

Though meaningful and worth discussion for purely personal decisions, it does not appear to apply engineering decisions.

Pleasure is assumed to be simple and intrinsically good. Similarly “public welfare” is often assumed to be simple and intrinsically good. Just as pleasure has been attacked as an imperfect goal, so, also, is “public welfare. We will address this next, as we examine the stakeholders associated with an engineering decision.

Stakeholders in Engineering Decisions

Does engineering mean selecting the highest quality material and the highest practical safety margin? No. Engineering means selecting the appropriate material and the appropriate safety margin, based upon Codes, experience and the intended use.

In this definition, the basic engineering function incorporates qualifications to simple, intrinsic good. The qualifications are the Codes, experience and the intended use - which implies cost.

In fact there are many groups of persons with qualifications they wish to impose for different reasons. These stakeholders and qualifications include the following:

the innocent (naive public)

- auto drivers
- long-haul truck drivers
- motorcycle riders
- delivery trucks

each business trying to profit from the construction

- design firm
- construction manager
- construction contractor and subcontractors
- Owner and owner's representatives

public services

- building standards
- EPA
- fire department
- police department
- storm and sanitary waste
- potable water
- public utilities - gas, electric, telephone, data

politicians seeking re-election

muckrakers

whistle-blowers

mis-informed partisans

This is not an exhaustive list, but it includes people who may disagree with your decision enough to go to court to get your decision reversed - and, possibly, seek damages from your firm. The stakeholders represent consequences, in the sense of the previous discussion of normative ethics. This is direct input to your engineering decisions and a balance point we may call engineering ethics.

narrative	I was thinking of an interstate highway bridge or parking deck when I made the list of stakeholders. I am an auto driver. I appreciate long merge lanes, banking on turns, control of rain runoff to avoid hydroplaning, lane stripes and rumble strips. Long-haul truck drivers don't like to tip over and don't like quick merge lanes, weave lanes or narrowing-spiral ramps. ... The design firm has a profitability goal and a stay-in-business goal. Value setting for design decisions can be badly distorted when the design firm is viewing imminent dissolution. In many government and large-industrial construction projects, the construction manager re-designs the installation. This almost always results from interferences and rarely involves review by the original designer. Thus, the first design decision is
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	not the one built and very different pressures are applied to the field trailer designer. One excellent electrical contractor I frequently work with bids generally from the construction drawings, but recognizes available savings by redesign, which he includes in his bid. We say rigid steel conduit; he says EMT or flex. And, he is always trying to use PVC and non-metallic flex conduit. He tends to group many more conductors in a conduit than shown on the NEC list at rated ampacity. Obviously the construction contractor is not influenced by Engineering Codes of Ethics. Profit isn't exactly the right word to use describing the motive of the Owner and Owner's Representative. During design, the Owner wants as many features as he can get and is willing to compromise on Building Code requirements and generally accepted design principles. During construction, the Owner's Representative wants even more. Public services, in the current discussion, refers to government agencies which have a vested interest in each decision that forms the design. Building Standards must review the design for Code compliance and provide inspection against the drawings during construction. Building Standards is very concerned about life-safety, but has little interest in limitations of current technology. Someone is going to have to maintain everything we build. For public projects, the maintainers are government employees. They have an interest in design decisions that are economically maintainable (shut-off valves located in reachable places). EPA is listed here because they frequently act in an insane manner. I have worked on several projects where EPA demanded technology which was not commercially available and/or not recommended for the application by the provider. Since EPA can hold up public funds and always inserts an approval delay, they are a stakeholder and very important to the designer and Owner. The Fire Department wants to be able to get their emergency equipment across the bridge, into the parking garage or up to the structure on fire. For the most part, the Fire Department does not get enough time to review the plans and is not consulted on field changes. The Police Department has never been consulted on any project I have worked in 35-years. They certainly have an interest in lighting, security and access for emergency vehicles. tow-trucks, in this case. The town where I work has occasional heavy thunderstorms. There are several interstate highway overpasses (highway goes under railway) that flood during and following these storms. From the depth of the water, they need pumps or a much better water runoff plan. This situation results from compromises made during design, oversights made during design or lack of follow-thru by the storm water maintenance agency. I assert that this is exactly the engineering ethics question which is the core of this course. The ability of ambulances to get thru is life-safety and public welfare. ... Politicians are part of the review procedure for public projects. It is sometimes hard to see the "public interest" that they are representing. In the town mentioned earlier, a 6-lane interstate enters from the south. A 6-lane interstate passes thru east-to-west. They join downtown in several miles of 2- and 4-lane highway. One of the original
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	designers told me that every report from their office indicated this scheme would be unworkable. The politicians insisted on it, and it works fairly well, except 7-10AM and 3-6PM, when traffic assumes stop-and-go mode. The political decision was to minimize impact on neighborhoods. Obviously, these politicians were elected by roadway neighbors, not roadway users. Another very obvious example of politicians and engineering ethics is best summarized by the electricity deregulation, out of Washington DC. The engineers' organization, IEEE, volunteered 1000's of hours of data gathering and presentation to demonstrate the adverse effects on the public of deregulating electricity. It is reported that ENRON donated about \$5,000,000.00 to the politicians on the committee to cause deregulation to move forward. In the town just mentioned, there are two tv stations with investigative reporters. Too many design decisions on public projects are formed to meet the requirement of hiding government operations from the muck-rakers. Muck-rakers do file lawsuits, which result in depositions, hearings, fines and revocation of professional licenses. Whistle-blowers are persons working within the project who are so offended by the decisions made that they forfeit future employment and accept public ridicule by informing the news media. Surprisingly, even though all stakeholders who were part of the decision agreed, a single person is usually elected to take all blame, go to jail if needed and pay any fines levied. Is it a valid execution of professional ethics to internally broker a decision which will not survive public review? This is the reason that some firms require a signed ethics statement forbidding any unethical behavior or behavior which might be viewed as unethical. (After they have the form, they can tell you to do anything, or lose your job, and probably be blacklisted, as well.) Mis-informed partisans are single-topic pressure groups who seek a particular goal, without regard to facts, effects on other interested parties or long-term consequences. Photo-voltaic electric generation is a good example. The technology uses extremely toxic heavy metals. It is dangerous to researchers and to production operators. It is dangerous to waste-water plants for normal waste and extremely dangerous to the community in the event of unplanned spills. Photo-voltaic generation is extremely expensive, compared to other sources and suffers deterioration and demise in the 5-10 year range. Photo-voltaic is promoted by green groups and rewarded as a design choice by a prominent quasi-governmental organization.
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If someone were to ask, you might say that different ethical standards that impact engineering decisions are Codes, health and welfare consequences of the naive public, profitability and survival of the design firm, political benefits, effects of public exposure, maintainability and special interest groups.

4 Action Items of the 1954 NSPE Engineers' Creed

The National Society of Professional Engineers publishes a Creed, which claims copyright protection and can only be paraphrased here. (<http://www.nspe.org/ethics/Code-2006-Jan.pdf>.) The Creed may not be specific enough to warrant carrying a copy in your wallet or purse.

I will use my professional knowledge and skill for the advancement and betterment of human welfare.

I pledge:

- To deliver the utmost of performance;
- To none but honest activities;
- To follow the laws of man and the highest standards of professional conduct;
- To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.

Being humble and seeking Divine Guidance, I make this pledge.

Advancement and betterment of human welfare.

Does this forbid participating in a project to tear down a good, old building and construct a crummy new building on the site?

How well does this match up to the WWII project to kill 400,000 Japanese? Maybe there are implied qualifications.

For over 50-years the public utilities worked very hard to eliminate the industrial electrical generation plants built in the 1930's. The plants provided local reliability, economy and competition. It was the competition the utilities wished to avoid. Where is human welfare in the utility PE's fighting local generation?

To deliver the utmost of performance;

The medical profession uses the following definition of standard of care,

<http://www.medterms.com/script/main/art.asp?articlekey=33263> : "The level at which the average, prudent provider in a given community would practice... The medical malpractice plaintiff must establish the appropriate standard of care and demonstrate that the standard of care has been breached."

This course is not offering legal advice. It would appear, however, that for professional medical services, the **average** practice is the standard, not the utmost performance.

none but honest activities;

The State Boards of Registration are very big on this. If a conviction is on record, anyone can bring it to the attention of the Board and get a hearing and some likelihood of revocation of the perpetrator's license. Is it honest for an engineer to have a close relationship with a single supplier without revealing this to the client? Most engineers have preferred providers and lack knowledge about competitors. Is this really honest, or just another example that concealed behavior is not actionable?

If an Architect shops a job among engineers to get the lowest price, and comes back for a second round, is this honest? (It is forbidden by AIA when the Architect is the design professional.) What percent of activity in your firm is obtained on this basis?

follow the laws of man and the highest standards of professional conduct

In this context, "Follow the law" usually means, "Don't bribe public officials". (Not to be confused with Political Action Committees or independent action groups set up by the state party.)

How should this NSPE mandate be interpreted when the owner of the firm says to give the checks to him and he will deliver them to the candidate?

The "highest standard of professional conduct" is too much for medical doctors, are we sure we wish to impose that upon ourselves. What about the lower half of our profession? Do we expect to catch all the errors in QA review or when Building Standards gets the permit set?

service before profit.

No. Survival is the primary objective. Service is an 8-5 deliverable, when it doesn't conflict with lunches or vacations.

narration	I have been trying to make this course an objective presentation of a range of standards and interpretations. The goal is to put you in a position to make a decision you can justify and live with. At this point, I must step outside that boundary. I strongly believe that a Client, Owner or Contractor should be able to leave a message and reasonably expect an answer the next business day. I don't see this level of service in more than 5% of the professional firms and persons I deal with. People don't check their voice mail and don't delegate when they are out of town. Nobody enforces a standard. (Some sales persons do respond.)
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place the honor and standing of the profession before personal advantage

I don't know what this means. I specify copper wire because 25-years ago there were fires when aluminum wire was used. The aluminum salesman says the problems have been solved and the Owner can save lots of money by using aluminum.

From engineering, I believe this to be true. From years of dealing with Owners, I don't want to start the discussion. It will go on-and-on, non technical people will make technical decisions using bizarre logic and misinterpreted experiences, and, I will have to defend the decision to every electrical engineer I meet. I am weak.

If it is a publicly funded project, we are wasting public money and adversely affecting the public welfare by wasting funds that could be put to beneficial use.

Being humble

My previous boss stated that he "knew everything". When I mentioned this at a meeting, he qualified it that he "knew everything about HVAC." There is something about being successful that includes a little arrogance. I am not sure that a survey of NSPE members would certify the propriety of this item of the Creed.

6 Canons of the NSPE

The National Society of Professional Engineers *2006 Code of Ethics for Engineers* is a very dense .pdf available at <http://www.nspe.org/ethics/Code-2006-Jan.pdf>. There is no claim to copyright. I emphasize the 2006 because the current version contains revisions to satisfy a ruling

by the Supreme Court regarding illegal restraint of trade. It appears that the Supreme Court sees an interaction between business principles and engineering ethics.

There are six fundamental canons, as follows:

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

These are the words held sacred by the various State Boards of Registration. Do not take them lightly!

1. Hold paramount the safety health, and welfare of the public.

Do you remember the Challenger o-ring catastrophe? Engineers warned that the o-rings were being used outside of specifications. NASA managers decided that political needs exceeded the predicted hazard. This brings up the question addressed previously about probability of future events and the recent topic of political benefit. The canon does not address 1.0, .1, .01, .001 or .0001 likelihood of catastrophic outcome. Do you think the NSPE hasn't heard of statistics or are they playing the political game?

2. Perform services only in areas of their competence.

I had an Executive Vice-President who stated that our firm would accept any design job where the Client's check was likely to clear. He stated we would hire people for skills we did not have. He made this statement at an internal meeting for all company employees. It was video-taped for review by persons on field assignment or out sick.

What does "competence" mean? I personally think it means "successfully completed a previous similar job through acceptance and commissioning".

Many firms take on jobs in areas where no one currently employed has experience. The worst place I ever worked kept issuing designs for ultra-violet disinfection of the discharge of waste water plants. The product had been radically modified from the form shown on the standard design. But, the same sheets kept going out on each new job. Reusing sheets has to do with profitability. Several people certainly got bonus checks for doing this.

3. Issue public statements only in an objective and truthful manner.

I am occasionally asked to attend meetings where the Owner, Architect, Designer and Supplier sit together and try to figure out what went wrong and how to get a system working before the pipes freeze.

The Owner and Architect are there to push for resolution and approve any costs agreed upon. The Supplier is there to avoid any liability. The Designer is there because everyone thinks that being able to read a catalog description makes you a technical expert.

At one meeting the regional Allen-Bradley drives specialist stated that model 1336 drives do not generate harmonic currents on the line side. He is wrong. Every detailed technical description of variable frequency drives comments on the need for line-side reactors or isolation transformers.

Am I supposed to go for his throat because they promoted a technician and did not train him?
Am I supposed to trust GE and Siemens literature, even though I have never measured total harmonic distortion or individual harmonics on any drive?

There is true merit in the NSPE canon, but it is nearly impossible in today's environment of de-skilling every job. Regarding variable frequency drives, I have taken courses from two persons I would consider experts, meeting the requirements of competence and truthful statements. They will take my phone calls.

4. Act for each employer or client as faithful agents or trustees.

A local lighting supply house does free design of school theatrical lighting. My peers and competitors put these drawings on a project border and issue them as construction documents. The drawings contain only vendor part numbers for the light board, dimmer panel, fixtures and interconnections. Am I acting as a faithful agent for the Owner in offering for competitive bid specifications containing only a single vendor part number?

I cannot stomach this. I create my drawings and prepare a Bill of Material with technical description of the required items. I send it to the supply house and request that they review the design, add or delete as needed and fill in the vendor part numbers.

The supply house fills in the part numbers. They do not identify missing pieces that they would normally supply without comment from the excess profit they are receiving. (The example is a stress-relief cable clamp used for the power cable up to the light bar.)

Nobody else will bid the theatrical lighting. Not even retailers for the same vendor. They protect each other. The other vendors have not developed this area. However, I could contact them in New York or Chicago and they would respond.

5. Avoid deceptive acts.

Twice I have been hired by firms that do not usually employ professional engineers. Both times, it was in response to a client request. Both times, I was promised a raise upon completion of the immediate project. Both times I was let go after the immediate project.

The first time, I knew they were unhappy with me because I asked about motor brakes on a slicer machine. I had done controls for several slicers for them and they always had motor brakes. The provider was saving money on this one.

In the second case, the Owner wanted a local PE. I became the local PE. I generated much ill will with my employ by trying to follow the National Electrical Code. They had to keep reminding me they didn't do it that way. In one case of direct violation, I asked for a letter. They gave me the letter, but no one would sign it.

Yes, I was disturbed about the disregard for safety for the machine operators, but I am mentioning it here because they promised a raise while very certain they never planned to deliver. I think there is a difference between engineers and technicians, and, apparently, so did they.

narration	This is a wonderful time to mention NICET (National Institute for Certification in Engineering Technologies) http://nicet.org/home.cfm . NICET is owned and operated by the NSPE (National Society of Professional Engineers) http://nspe.org/ . NICET was set up by one professional group to control another professional group. The only easy way to determine the relationship is to check the mailing addresses at
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	the bottom of the web homepages. Interestingly, the NICET Code of Ethics has a very different direction than that of the NSPE. Neither indicate a claim for copyright protections. NICET Code of Ethics NICET-certified engineering technicians and technologists recognize that the services they render have a significant impact on the quality of life for everyone. As they perform their duties and responsibilities on behalf of the public, employers, and clients, they shall demonstrate personal integrity and competence. Accordingly, certificants shall: 1. Have due regard for the physical environment and for public safety, health, and well being. If their judgment is overruled under circumstances where the safety, health, property, or welfare of the public may be endangered, they shall notify their employer, client, and such other authority as may be appropriate. An employee shall initially express those concerns to the employer. 2. Undertake only those assignments for which they are competent by way of their education, training, and experience. 3. Perform their duties in an efficient and competent manner with fidelity and honesty. 4. Admit and accept their own errors when proven wrong and never distort nor alter the facts in an attempt to justify their decisions. 5. Avoid conflicts of interest whenever possible. When unavoidable, they shall disclose to their employer or client, in writing, any action that might create the appearance of a conflict of interest. 6. Avoid receiving and granting bribery in all its forms. 7. Strive to maintain their proficiency by updating their technical knowledge and skills in engineering technology. 8. Not misrepresent or permit misrepresentation of their own or their associate's academic or professional qualifications nor exaggerate their degree of responsibility for any work. 9. Not reveal facts, data, or information obtained in connection with services rendered without prior consent of the client or employer except as authorized by law.
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6. Conduct themselves honorably, responsibly, ethically and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Does this say, "Don't get caught?"

Wikipedia, <http://en.wikipedia.org/wiki/Honor>, distinguishes between cultures of honour and cultures of law. In a culture of law, the participants give up most of their rights to defend themselves on the understanding that transgressors will be apprehended and punished by

society. In a culture of honour, usually where law enforcement is unavailable, cultivating a reputation for swift and disproportionate revenge increases the safety of one's person and property.

We know from recent national experience that "lawfully" means "committed with a component of plausibility deniability for the person in charge." http://en.wikipedia.org/wiki/Plausible_deniability.

"Responsibly" has something to do with beer, in the popular vernacular. Heineken, www.heineken.com/usa/cc/responsibly/default.aspx, seems to say that drinking to excess is ok if you do not drive immediately afterwards. Perhaps this has a parallel of a construction contractor supplying a low-strength concrete mix so long as the design safety margins keep the structure from falling before occupancy.

The NSPE demands conduct to enhance the honor, reputation and usefulness of the profession. I believe close reading of this statement adds the word **visible** to conduct, because the public can't prosecute you on things they can't see. Hire a good PR firm for reputation and conceal the worst offences you commit.

38 Professional Obligations

The National Society of Professional Engineers 2006 Code of Ethics has four major headings,

- I. Fundamental Canons
- II. Rules of Practice
- III. Professional Obligations
- IV. Weasel words to comply with the Supreme Court ruling but still claim to be right

The Rules of Practice contains elaborations on the Canons, with examples. The Professional Obligations appears to codify answers to specific questions which have been asked. By providing this list, a single engineer cannot complain, "that's not right!" The NSPE has specifically stated that it is right.

The place to find the 38 Professional Obligations of the NSPE is in Part III of the Code of Ethics of the NSPE. In this course, we will not examine those that are reasonable. However, we will look at several which appear peculiar.

1.b. Engineers shall advise their clients or employers when they believe a project will not be successful.

Most places, engineers do not talk to Owners, they talk to Engineering Managers. Engineering Managers scrub any negative implication from reports they give to Owners. There appears to be a goal of screaming, "We can save it!" as the project goes down the tubes. This is especially true when the engineering firm goes down the tubes with the project. Please jump to the National Academy of Engineering Challenger example below for validation of this view.

5.a. Engineers shall not accept financial or other considerations, including free engineering designs, from material or equipment suppliers for specifying their product.

This is exactly the theatrical lighting example cited in the Canon 4 discussion above. It applies equally to Kitchen Equipment Contractors, Lab Furniture Contractors and Millwork (cabinetry) contractors.

7.0.ii. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action.

This is a mandate. Thou shalt present such information to the proper authority.

National Academy of Engineering version of the Challenger Disaster

Obviously, when a very visible catastrophe occurs with loss of life, the facts of the situation begin changing immediately (see 11 levels of truth in the Meta-Ethics discussion). The National Academy of Engineering version of the Challenger Disaster, <http://www.onlineethics.org/essays/shuttle/telecon.html>, is based upon contemporaneous notes and memoranda. You are urged to study the reference material at your leisure and reach your own conclusions about veracity of the statements and the ethical participation of Morton Thiokol and NASA managements and the engineers who presented unfavorable data.

Your instructor's understanding is as follows:

The night before the cold weather launch of the Challenger, there was a conference call between Morton Thiokol booster manufacturing and Marshall Space Flight Center NASA managements. Morton Thiokol o-ring specialists participated and recommended no-launch.

Morton Thiokol requested an off-line caucus. The National Academy of Engineering account states that General Manager Jerry Mason told Vice President of Engineering Bob Lund to "take off his engineering hat and put on his management hat."

When the call with NASA resumed, Morton Thiokol management recommended launch and NASA agreed.

National Academy of Engineering version of Unsafe Procedures at Hanford Nuclear Reservation.

This report comes from the whistle-blower. There are public documents and *New York Times* articles cited in the article to help decide the veracity of the account. Please review the National Academy of Engineering version at <http://www.onlineethics.org/moral/austin/index.html> to form your own opinions.

Your instructor's understanding is as follows:

Inez Austin had a job with Westinghouse, contractor for the Hanford (nuclear fuel) reservation. She prepared a procedure for safe pumping of liquid waste from a single-wall underground tank to a double-wall underground tank. In her procedure, she noted special precautions for handling unstable ferrocyanide.

Her boss removed the warnings on ferrocyanide and asked her to sign the procedure. She refused and suffered revenge from Westinghouse and the nuclear industry.

National Academy of Engineering version of Structural Deficiencies in the CitiCorp Tower, New York City

This is a rare report of a potential catastrophe, which was avoided by ethical behaviour at tremendous personal risk, followed by career continuity. It is recounted by William LeMessurier, the consulting structural engineer and accompanied by a videotape and downloadable QuickTime clip at <http://www.onlineethics.org/moral/lemessurier/index.html> and reference to a *New Yorker* article. You are urged to review the primary references.

Your instructor's understanding is as follows:

LeMessurier was consulting structural engineer for the architect who designed the 915-ft, 59 story CitiCorp Center on Lexington between 53rd and 54th streets. The building starts 9 stories above the ground to accommodate a church which was part of the land acquisition deal. It uses mid-wall columns and has open corners, to accommodate the church.

After LeMessurier was off the job, the contractor changed the welded joints to bolted joints.

LeMessurier found out about the bolted joints and started worrying about the reduced rigidity and response to quartering winds (diagonal - hitting two walls simultaneously).

LeMessurier assigned review of the structural support, using bolted connections, to his structural engineering class at Harvard. The verified conclusion was that the building was vulnerable to total collapse in a normal, heavy storm.

LeMessurier contacted the Owner, Architect and City. An expedited repair plan to weld “band-aids” over the bolted joints was undertaken. It was successful.

Press reaction was favorable. LeMessurier’s liability insurance premium was reduced.

James Watt’s Rejection of High-Pressure Boilers

This moral exemplar is offered here because it provides another example of a personal investment in an ethical decision, with commercial implications. It ties in nicely to the discussion of levels of truth in the Meta-Ethics sections. Experts and truth have some sort of mystical relationship, at least on television and in the newspaper.

The external reference for this story is the Wikipedia article on James Watt, http://en.wikipedia.org/wiki/James_Watt especially the section headed, Controversy. Please pursue this link for an entertaining insight into the Industrial Revolution and the humanity of the participants.

Your instructor’s understanding is as follows:

James Watt developed and patented many significant improvements to the Newcomen engine which had remained essentially unchanged for 50-years.

He is known for two business decisions that he followed: patenting other people’s inventions and refusing to personally work on high-pressure boilers, which he considered inherently life-threatening.

Interestingly, his partner, Matthew Boulton, and their firm Boulton and Watt, made a lot of money from high-pressure boilers.

Watt is frequently referenced today for his steam engine innovations and his opposition to high-pressure boilers.

The Oppenheimer Controversy about Nuclear Weapons

This is the story of a very ethical dilemma faced by technologists. The facts are undisputed, but a range of interpretations and conclusions were made in 1946 and are still being argued today.

Please check the links to J. Robert Oppenheimer, an extremely interesting person, at http://en.wikipedia.org/wiki/Robert_Oppenheimer. His team, which created and tested the first atomic bomb was made up of the greatest minds of the era, see especially Richard Feynman, <http://en.wikipedia.org/wiki/Feynman> and http://www.amazon.com/s/ref=br_ss_hs/104-2380834-4683145?platform=gurupa&url=index%3Dblended&keywords=feynman.

Your instructor’s understanding is as follows:

Robert Oppenheimer was an acknowledged genius. He missed a year of high school because of colitis, but received his PhD from Harvard in physics in 1926 at the age of 22.

He contributed to left-wing efforts, including the Republican side of the Spanish Civil War and the Communist Party. He never joined the Communist Party, but his brother, Frank, did.

In 1941, Oppenheimer was part of the Lawrence Radiation laboratory in Berkeley, CA. When the Army took over the bomb development, now called the Manhattan Project, the project director, General Leslie Groves appointed Oppenheimer as scientific director, over objections of the FBI. Oppenheimer consolidated the project efforts at various universities to Los Alamos, NM, a site near his home.

In 1945, a group of the scientists circulated a petition against using the atomic bomb on civilians. Oppenheimer opposed the petition and kept bomb development on schedule.

Current estimates are that, overall, 400,000 Japanese died.

In 1946, Oppenheimer was appointed Chairman of the General Advisory Committee of the US Atomic Energy Commission. In 1949 he recommended pursuing power from nuclear fission instead of a hydrogen bomb. He was overridden by President Harry Truman. In 1951 he changed his mind after reviewing the Teller-Ulam design for a hydrogen bomb.

In 1954, politicians arranged for President Eisenhower to revoke Oppenheimer's security clearance, on the basis of FBI reports.