Ethics and Floodwater Engineering – 4-Hour

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Couse Description

This course satisfies 4-hours of engineering ethics continuing education requirement for Professional Engineer license renewal.

The course in engineering ethics and floodwater engineering is intended to encourage the engineer to consider the big-picture result of decisions using real-world examples from a licensed Professional Engineer with extensive experience in Floodwater Engineering.

The engineer’s duty is to make things work. Following instructions, complying with the law, and using current best practices are usually good enough for the present. But the engineer’s task to make things work in the future. This requires making projections about future conditions and use. While engineers prefer hard facts, we are sometimes forced to work with “soft data” that require evaluating many possible options. During this evaluation, we use legal requirements and best technology as tools. Ethics can be used as a third tool to make decisions. “Ethics and Flood Water Engineering” contains many examples of using ethics in real-world situations to make engineering decisions.

Objectives

At the conclusion of this course, the student will have read and evaluated:

- Considerations for the long-term implications of design decisions beyond code requirements
- Considerations and implications when forced to work with “soft data” that require evaluating many possible options
- Use of legal requirements and best technology as tools
- Consideration of the use of ethics as a third decision making tool
- Review many examples of using engineering ethics in real-world situations to make engineering decisions

How to Read this Course

The student is required to thoroughly read and comprehend the course material and examples

In order to complete the course, the student must pass the quiz in the final chapter of the course. It is recommended that the student keep these questions in mind as the course is read.

Topics Covered

Introduction, Engineering Ethics, Floodwater Engineering, Real-World Examples of Engineering Ethics in Floodwater Engineering Applications.

Grading

Students must achieve a minimum score of 70% on the online quiz to pass this course.

The quiz may be taken three times.

The student will be asked at the end of the quiz to attest that he or she has personally and successfully completed all chapters of instruction.

The quiz may be viewed in the final chapter of this course.

Couse Inquiry

This course is designed to be interactive. The student is encouraged to contact us to discuss any questions that arise while taking this course. All inquiries will be answered within two days or less. The reader can contact PDH*Now* as follows:

By Email: info@pdhnow.com

By Phone: 1-833-PDHNOW9

Table of Contents

Ethics and Floodwater Engineering - First Hour

Introduction

This 4-hour course (4PDH) discusses engineering ethics as applied to many situations involving floodwater.

My name is Don Soards. I am a register professional civil engineer. I had a 31-year career as a civil engineer with the US Army Corps of Engineers and have been active in many phases of engineering dealing with floodwater.

All the examples used in this course are from my own career.

In order to avoid any vulnerability to governing bodies, projects, or individuals I have omitted names of places and people.

Floodwater engineering is a less precise field of technology than most other forms of applied science. However, all forms of engineering involve some degree of error tolerance when estimating variations in materials, variations in manufacturing or construction technique, formulas not exactly matching conditions found in nature, variations from estimated design inputs, end-user behavior deviations from expected use, and most importantly unique site requirements beyond those considered by design code.

It is the engineer's job to make the system work in spite of "error tolerances". Ethics can greatly aid the engineer with this task.

The gap between the black and white world of "by the book" and system reality is a gray area. One aid to successfully traverse this gray area is to ask the question, "What is the *right* thing to do?"

Ethics enables us to balance error tolerance, code inadequacy, and system sensitivity. Ethical solutions are more functional products and in the long-run save our society money and time. In many cases applying ethics allows the engineer to quickly grasp the right qualitative solution – one that gets the job done and is supported by the people involved.

Definition

Ethics are moral principles that govern the behavior of an individual or group. "Principles" means "rules" and "moral" means behavior that is consider right or at least acceptable in society.

Engineering ethics sets the obligations by engineers to themselves, their clients, society and to the engineering profession.

Society means all people who will use or be affected by your work.

"Situation ethics" is a judgment based more on the context of a situation rather than absolute moral principles.

The concept of ethics and situation ethics is somewhat analogous to statutory law and case law. As a practical matter it is impossible for legislators to consider all possible situations when making a law, so society depends on case law to furnish context specific judgments.

Essentially, ethics is a battle of ideas about "good".

Unfortunately, moral principles can conflict with one another. For example, when we talk about good, we have a contextual reference about "who" it is good for.

Is it good for the engineer personally?

Is it good for the engineer's client?

Is it good for society?

Is it good for the engineering profession?

Frames of reference answer the questions who, what, where, when, why and how. "Who" may be divided into categories of "what" (handicapped) or "where" (residents of a particular city or state) and "when" (present or future residents). "Why" may refer to funding considerations and "how" may be a selection of the best technology or cheapest alternative.

Given 4 entities and 6 frames of reference creates a matrix of 4x6 = 24 possible perspectives. No wonder answering the question about "What is ethical?" is so confusing!

My first ethical work consideration on an engineering project (chip seal road repair) occurred when I was in college.

I was given a 35-lb bucket of oil and told to put it into the road cracks. I was followed up by a "sander" who dumped sand on my oil. I was immediately confronted with the ethical dilemma caused by traffic. It was easy to pour oil in cracks off the edge of the road, but more difficult where there was danger of being hit by a car. At this point there was a question of "who is this good for?" The sander was scared too and suggested that once the chip seal went down no one would know the difference.

I developed my own ethical policy for danger areas of just repairing the neediest spots very quickly with more of an eye for traffic than workmanship. I used this road a year later and didn't notice any defects. Problem solved.

I was fortunate that a solution that was "good enough" for all four players existed. In this case I stayed alive and on the payroll; the company got their product to work without the mess of filing insurance claims for a worker hit by a car; society got a good road; and our profession can once again be respected for service rendered.

Applied Engineering Ethics

Applied engineering ethics consists of finding a solution that will satisfy all.

Unfortunately, as game theory teaches us: We can only maximize one variable at a time.

For example, consider the case of dollars in your pocket, gas in your car's gas tank, and food in your tummy. These are three variables. If you try to maximize any one, it will be at the expense of the other two. Say you stay home and save your money, then your car will not have gas and your stomach will be empty. If you get gas you will lose money. If you buy food, but no gas your car may stop before you get home.

The solution to this problem is to write a combined function containing all three terms like:

My happiness = f(dollars) + g(gas) + h(food)

Now you have one variable "My happiness" to optimize. However any solution must satisfy the requirements for each term separately. Your solution must allow enough gas to get back home, enough food to stay alive, and enough money so you know where your next meal is coming from.

This leads to solutions that are "good enough" for all players rather than optimal for any one player at the unethical expense of others.

Ethical concept: Select solutions that are "good enough" for all parties, rather than optimal for any one party.

Corollary: "Better" is sometimes the enemy of "Good".

The quality we put into our work is at a cost to ourselves. It takes more time and other resources to do a better job. If we are lucky we can find a balance among all four of the players (you, client, society and profession).

However, sometimes we are not in control of the work.

One day our crew was assigned to install a corrugated metal pipe. The culvert was to lie directly on the bottom of a small wash. The pipe was rolled off a flatbed truck and into the wash. Then we started shoveling dirt at the bottom of the pipe. One husky lad had a hand compactor and jammed the dirt under the pipe. This process continued until our foreman left. Quickly, the guy with the hand compactor put it down, grabbed a shovel and started shoveling furiously. He said no one would ever know. Some of the others followed his lead. We were now placing uncompacted fill under a floodwater conveyance structure and putting it at risk to failure by piping through the uncompacted fill.

Personally I was surprised. We weren't getting paid anymore and would just go back on the road crew as soon as the culvert was finished. Then I realized that holding the hand compactor at an angle was very hard work and maybe even hard on the worker's body. So the worker made a decision that was good for him. However, this wasn't good for his client (the firm we were working for) or for society (including our firm's customer) if the pipe and gravel road washed out. The worker was clever, but unethical. He tamped the last few lifts to make it look good. What he should have done is ask someone else to take a turn with compactor. I was curious and would have liked the opportunity myself.

Ethical concept: Unethical behavior eventually tarnishes the purveyor's reputation.

Our society acknowledges this with famous quotes like the one from Abraham Lincoln: You *can fool all* the people some of the time, and some of the people all the time, but you cannot *fool all* the people all the time.

In this example what the unethical worker didn't know was that my dad's group was the customer our firm was installing the culvert for.

I had a construction option on my civil engineering degree and my first job after college was working as a construction superintendent for a residential home builder. I was in charge of 100 homes being constructed by 26 subcontractors. The housing firm was strictly management with a focus on sales. All work was accomplished using "subs" and I was the interface between them and the firm. This was on the east coast during the early 1970's and there was a huge mistrust of management by labor. Getting everyone to work together was the longest six weeks of my life. 19 of the 26 subs "fell in line" quickly. The others required special handling.

My dad was a carpenter before he became a civil engineer. I learned about house construction by helping him build a retirement home for him and my mom. This knowledge helped me to get along with the subs.

My first big break came when the state sent a crusty old inspector to our site. He pointed out construction flaws that I hadn't noticed. I then pointed these out to the subs. *I was surprised that I didn't a single negative reaction!*

Each sub had a personal ethical dilemma. If they did a crappy job, they did it slightly quicker and easier. A crappy job was optimizing their money at the expense of society (the people my firm sold the houses to) and didn't make any profession look good.

Ethical concept: However, what I observed was that no craftsman likes to do substandard work. Deep inside of most of us is an ethical person.

My inspection of their work gave them an excuse to "do the right thing" (which is really what almost all of us want to do anyway).

Almost all workers want their work to be "*good enough*" for society.

Gaining money by unethical means is frowned on by society and is illustrated by sayings like "easier for a camel to get through the eye of a needle than for a rich man to get into heaven".

Ethical concept: Almost all of us want to do right by society.

Unethical Workers:

I worked personally with the foremen of 6 of the last 7 subs I was having difficulty with. This was during a wage-price freeze and some of the subs were losing talented workers to other firms who had slightly higher wages before the freeze. I was in an awkward position because I was competing with our firm's other housing development for scarce workers. Eventually, these 6 subs started giving our development proper support. I now had 25 of 26 subs supporting our development.

The last group I couldn't get proper support from was the painters. I even had to settle a house and have people move in when we hadn't painted their steps. The new homeowners were gracious, but I knew this wasn't right. When I talked to the painters I didn't sense any camaraderie. I never could arrange a meeting with the paint foreman.

The lesson I was about to learn was:

When faced with normal work requests evasive people are generally less ethical – much less ethical.

I am not talking about avoiding some stalker or crazy person. We all must do that for our own safety. We tell kids not to open the door to strangers. Nor am I criticizing reticence when someone asks us for trade secretes or classified information. I am specifically talking about devious behavior being substituted for honest information.

I got a break dealing with the painters. One problem our salvage sub was having was that someone was stealing “overages” of cinder block. Cinder block is delivered on pallets of a fixed number. The masons always order a few extra blocks in case of breakage. Then those few extra blocks are left along with other trash to be picked-up by the salvage sub. Those few good blocks are part of the salvage subs compensation for picking-up the construction debris. A few extra blocks per lot can add up to a significant amount after 100 lots.

I couldn’t find out who was doing it. (No one wanted to be the rat.) So, I stayed after work. I didn’t have to wait long. A white van was already there. I watched from the shadows of a partially constructed house. I recognized some of the painters loading good cinder blocks into their van. I stepped out of the shadows and they saw me. I didn’t say anything. They closed the rear doors and tried to drive away but got stuck. I just stood there while they got unstuck and eventually tossed the cinder blocks out the door.

The next morning, I got to work at 7:30 a.m. and went to the house where I couldn’t get the painters to finish the steps. I met the smiling husband coming out of the house. The painters had showed up at 6:30 a.m. that morning and painted their steps!

After that I never had to ask the painters for anything. They just did their jobs in a timely manner. Also, the theft of cinder block stopped. Problem solved.

Personally, I don’t like doing business that way. I try hard to avoid doing business with unethical people. Unfortunately, when I have been forced to deal with marginally ethical people I have had the most success when I was a threat to their economic well-being. Unless, you are a threat to their well-being, they think there are no consequences to abusing you for their own personal fun and profit.

Bait and Switch:

I much prefer to deal with honest people, even if they seem harsh or abrasive. Even if I don’t like what they have to say, I at least know where I stand.

As far as identification of evasive types goes, I can offer the following observations. Every Meyers-Briggs personality type has the ability to be ethical or unethical. However, two groups stand out. The entrepreneurial ENTP (extraverted, intuitive, thinking and perceiving) is highly manipulative and is prone to unethical behavior like “Bait and Switch”. These fast talking “wheeler-dealers” (think oil man JR Ewing on the famous TV show “Dallas”) can display little respect for conventional rules in pursuit of their goals.

For example, during the first year I was a college math tutor, I had four young female student’s try to get me to do their homework. All four were ENTP’s who were more than capable of doing the math assignments (NT’s are the best at math). They just wanted to see if they could “bat their eyelashes” at some old man and charm him into doing their work for them. The only golfer I have ever seen drop a club when another golfer was putting was an ENTP. Most ENTP’s are ethical, but there is a greater tendency for their imaginative (N) and unstructured perceiver (P) to conjure up “one-upmanship” ideas that benefit them at the expense of customers and society. Beware when an ENTP is evading your normal business request; you may be the next victim of unethical behavior.

The second group is immature feelers. All thinkers feel and all feelers think. However, thinkers tend to make decisions based on what they think will achieve their goal. Feelers tend to make decisions based on their feelings about someone or something. The problem dealing with immature feelers happens when the item in question is unpleasant or threatening to them. They can be so uncomfortable with confrontation that they simply avoid you and the item. In these cases someone else has to do their job for them. This type can string you along, take no productive action and then finally have some “protector” tell you off.

Are all feelers this way? Fortunately, not. Many plunges ahead almost fearlessly. The key is to notice whether they are evading your request.

Ethics versus Competence

People sometimes confuse results and effort. Some blame a person’s character for failure, when in fact the person is under resourced to do the job. By under resourced I mean lacking in guidance, understanding, time, funding, political support, etc.

When a professional baseball player strikes out, a pro golfer fails to break par, or a technical person fails to do something different that has never been done before, does it mean they are unethical? Of course not. Some challenges are too difficult to be successful every time. It took Thomas Edison over 10,000 tries before creating the first incandescent light bulb.

Even in the Wikipedia engineering ethics section some pre-1900 bridge builder is taken to task when failing to properly consider wind loading *before* there were design codes.

Some of our design codes are based on analysis of previous failures.

Some projects that met current design code during construction are still dangerous, as in the case of earthquakes causing upper level bridge decks to collapse and fall on traffic below. Our codes and engineering design ideas are based in part on the study of past failures as well as introductions of new construction materials and new design ideas.

Simply put, an engineer's job is to hit a moving target with an ever-changing gun, and then be shamed for missing.

This attitude was conveyed to me when I took a job with a state highway department. I had only been on the job for a week when my supervisor informed me, *"That if I designed a bridge that collapses, I'd better be underneath it when it went down."*

Knowing society's attitude about engineering structures that don't function in every imaginable condition is to blame all engineers still living (or even their descendants or their firm many generations later) should be enough to make every engineer error slightly on the side of caution.

Ethical concept: When faced with a design choice consider the more conservative option to protect you, society and our profession.

Ethical concept: Beware of any client who is dangerously underfunded. If a structure fails all blame will point at the engineer.

Stronger than Code:

My next career stop was as a civil engineer with the US Army Corps of Engineers where I would remain for the next 31 years until I retired.

I was placed in a two-year rotational training program. One of my earlier stops was the structures section. There I was placed under the tutelage of a very kindly gentleman who had designed the tallest tower and one of our longest bridges in our district. My job was to design a concrete gate-well structure over 20-feet deep. The function of the gate-well was to drain a large stilling basin. I went through the manuals and computations (mostly by hand back then) and when I finished I determined that the structure needed #4 bars placed every 10.75 inches. My tutor told me to just use 10 inches. Still believing in the infallibility of book learning I was a little surprised, so I ask why the change. The answer was, **"to make it stronger and easier to construct"**.

This is an ethical judgment that engineers get to make. This change does add the cost of two additional reinforcing steel bars, but a 10-inch dimension is easier (simpler) to construct accurately and does make the structure a little stronger. Forty years later his tower and bridge are still standing, and my gate well is still functioning.

Ethical concept: Make it stronger than code and easier to construct. You will be protecting everyone.

Future Variations:

One of my other stops was in the flood plain section. There they did something they don't teach in textbooks. They analyzed flow that wasn't in a confined channel. One of my first assignments was to code a small backwater model. The reach contained a small bridge with two 4'x8' concrete box culverts. I input coded according to the manual and gave the coding sheet to my new mentor. He looked at it for a minute and then slowly said, "Where did you take your clean water hydraulics at?"

This hit me like a thunderbolt! All my academic training used clean water. But floods are anything, but clean water. There are full of sediment, debris, trash, logs, and even an occasion car, shopping cart or mattress. He said we needed to add a little something in for "trash allowance". In this case we could expand the middle pier by a foot in width. I asked how do we know how much to add and he replied, "Just look upstream and see what's headed at you."

Just because the software manual doesn't specify something that you see in reality (like dirty floodwater) doesn't mean you shouldn't alter input parameters to take observed reality into account. Making flow conveyances slightly larger to handle unknown factors is good design. Using trash reduced areas for bridge flows when doing flood insurance studies results an a very slightly higher 100-year flood plain. This is good analysis.

Ethical concept: Allow for future variations by designing for more than average conditions.

Fox Guarding the Hen House:

I rotated out to a extremely large earth embankment dam and reservoir project. I worked with the government inspectors taking soil samples. We were performing what was called "acceptance testing". I developed an eye for properly compacted soil. I also heard what the government field staff thought of a new construction management technique called "contractor quality control". In previous projects the government did the testing and ordered the contractor to add water or remove bad fill. However, this made the government liable to many claims. Contractor quality control did eliminate the claims, but it also eliminated honest soil testing. The lab performing the tests was being paid by the contractor! Naturally they didn't want to bite the hand that was feeding them.

One morning the inspectors were all talking about the new guy on the night shift in the contractor quality control lab. He had performed a moisture test that failed slightly. It was only about one-percent below contract requirements. He had written the result on the lab report sheet that was posted in the contractor quality control lab. However, it didn't stay there long. I was shown the revised sheet that had a big erase mark on it. The test results were revised upward to just meet government specifications. I was then informed that the "independent" lab's tests had always past.

Out on the embankment one inspector explained how the contractor's lab got every test to past. They simply tested the harder spots on the embankment. Sometimes they would even take a sample in an equipment tract in order to ensure maximum compaction. As you look at an embankment under construction for test purposes, you are supposed to take a "typical sample" that represents an average condition.

Why was the contractor quality control lab unethical? The independent lab wasn't getting paid directly by the government. They were getting paid by the people they were supposed to be monitoring.

Ethical concept: Construction inspection firms must be paid directly by the customer and not by the contractor who is being monitored.

Being Ethical Empowers Your Subordinates:

My first job off the training program was as office engineer for the Corps on an extremely large earth fill dam. There were over 400-line items on the monthly bill. Additionally, we had contracts for utilities, operator's quarters, and a road. I stayed busy. I also learned a lot from the very experienced crew.

My position was ranked under the resident and project engineers. So, I didn't get to be the boss very often, but I knew what to expect from the contractor. My first counterpart with the embankment contractor was an ethical engineer. It was good dealing with him on the inevitable modifications that happen on large construction projects. Unfortunately, he transferred to another project and was replaced by a marginally ethical go-getter. One day both top men weren't there, and it was my turn to run the show. My experience with so many residential subcontractors taught me how to play “stump the rookie”. I didn’t have to wait long. The call came just after 9 am.

The project radio had a call from one of the inspectors on the embankment. The contractor had put “fatty clay” on the embankment. The problem with fatty clay is that it swells when it gets wet and then shrinks when it dries leaving a hole in the embankment. This could contribute to a piping failure of the embankment followed by a dam break.

The inspector wanted it removed and the contractor didn’t want to. The contractor wanted my decision. When I arrived the embankment, contractor had a contingent of office and field personnel and even had high ranking corporate visitors dressed in suits to watch him “stump the rookie”.

I looked at the fatty clay. It was easy to spot because of its dark brown color as opposed to the pink clay and light brown random fill. Fatty clay is very greasy. It is slick to the touch. I observed the heavy equipment spinning wheels on the greasy surface. The inspector was right to have it removed.

I looked at the inspector. He was “sweating bullets”. Cautiously he explained that he thought that the biggest area of the clay

should be removed. I then turned to the go-getter. He had a sneer on his face and the many of the others had a smug smile. He said, “We don’t have to do that. Do we?”

I held my hands up to frame the reach that our inspector wanted removed and said to the go-getter: “I agree with you about not taking out this amount.” I paused. Everyone on the contractor’s side was smiling. Then I doubled the space between my hands to include every crumb of fatty clay on the embankment and said, “I want all of it out NOW!” The smiles vanished. No one said anything, but the inspector gave the contractor that “you heard the boss” look. I left. That was the first and last time any contractor on that project invited me to question an inspector’s call.

Ethical Concept: Being ethical empowers your subordinates.

Questions to Consider – First Hour

What are some error tolerances you have experienced in your field during your career that made you feel uncomfortable?

Have you ever experienced the gap between the black and white world of "by the book" and system reality?

Did you ever have to decide "What is the right thing to do"?

When looking for a good answer did you balance system sensitivity with error tolerance or code inadequacy?

Save Time and Money:

Ethics can be used to save time and money.

Have there been times when you used ethics to speed up planning by eliminating unethical alternatives?

Have you ever used ethics to cut short excessive design iterations or useless refinements?

Have you ever enabled builders to act ethically with proper inspection and work monitoring?

Over-optimization:

Over-optimization can be a problem.

Can you think of anytime in your career that you found a solution that was good enough for all, but not optimum for anyone?

Have you ever wished you had left something alone? Was it a case of "Better" is sometimes the enemy of "Good"?

Professional Reputation:

Our professional reputation is important when marketing our services.

In your work decisions which do you put first: you, client, society, or profession?

Have you ever been in the awkward position of having to go along with something you didn't believe was right?

Have you ever been thought unethical because you didn't produce the results someone wanted?

Have you ever been under-resourced to do a job?

Have you ever planned, designed or constructed anything better than Code?

Unethical:

Minimizing contact with marginally ethical people can help minimize trouble in our careers.

Can you name three marginally ethical people you have been forced to work with?

Have you experienced an evasive person at work? Did they turn out to be very ethical?

When you were first starting out did anyone try to take unethical advantage of your limited experience?

Have you experienced unethical treatment because someone had financial conflicts of interest?

Summation of 1st Hour

- Select solutions that are "good enough" for all parties, rather than optimal for any one party.
- "Better" is sometimes the enemy of "Good".
- Unethical behavior eventually tarnishes the purveyor's reputation.
- No craftsman likes to do substandard work. Deep inside of most of us is an ethical person.
- Almost all of us want to do right by society.
- When faced with normal work requests evasive people are generally less ethical – much less ethical.
- When faced with a design choice consider the more conservative option to protect you, society and our profession.
- Beware of any client who is dangerously underfunded. If a structure fails all blame will point at the engineer
- Make it stronger than code and easier to construct.
- Allow for future variations by designing for more than average conditions.
- Construction inspection firms must be paid directly by the customer and not by the contractor who is being monitored.
- Being ethical empowers your subordinates.

Ethics and Floodwater Engineering – 2nd Hour

In the second hour we will continue with actual examples of ethics applied to floodwater engineering.

After the dam was completed, I went into the flood plain section. I worked on computing flood plains for flood insurance studies and for project economic studies. I was trained by a master. Computing open channel flow in marginally confined irregular areas is more difficult that it sounds. Engineers tend to value concrete above dirt and hence give more esteem to flow computations in concrete structures when in fact analyzing flow outside of confined channels and pipes is far more challenging.

Many times, I have seen “dirt solutions” using zoning be far more cost effective than structural ones.

Hand computations and a backwater computer model are the tools of choice.

We all know that water flows downhill, so how hard could this be? Floodwater engineering analysis uses some relatively simple rules in a highly complex fashion. It is like playing chess. One can learn the rules of chess in under five minutes but spend a lifetime on the complex application of those simple rules.

Balance Risks

After being in the flood plain section for four years I had modeled many actual floods and computed many “theoretical flood plains”. In the last part of the 1970’s our drought ended with a huge snowpack. Runoff from the snowpack threatened one of the towns I had computed flood plains for as part of a flood insurance study. The Corps geared-up for a flood fight. Before the runoff started, I examined the town levees. They were so narrow that I got out of the car and measured my wheels and the top of the levee width. There was less than one foot of clearance between my wheels and the edge of the levee and the edges were starting to slough off. I carefully backed off the levee. I walked and measured. The levee was dotted with small trees and was too narrow to support any traffic. We could never get trucks on the levee to dump rock on levee break, or even to add bank protection in the case of severe erosion. Also levee patrols could not be made driving a car. I recommended that we *lower* the levee. This decision required doing something that was counter-intuitive to many people. But the major risk to levees in our area is failure due to bank erosion rather than a general overtopping. We needed a road wide enough to accommodate a dump truck carrying large rock. As part of our flood fight both sides of the levee were lowered which widened the top.

Ethical concept: Engineering decisions need to balance all risks, no matter how counter-intuitive.

Ethical Decisions Require a Balance:

The river had levees on both sides. One levee protected most of the town. The other levee protected a rural area with a few expensive homes and the local golf course. The temptation to want to protect every one against the largest possible flood is strong. However, the problem with such a goal is that means the entire levee system would break on both sides at the highest level it could stand. This would send a sudden wave of water through both sides. The damage in town would be devastating and would likely result in loss of life. If the levee break happened while most people slept a greater loss of life would occur. I had to make sure that the levee would break on the sparsely settled side first. That would reduce flow in the river and the combination of overbank and river flow might be enough to pass the flood wave without harming the town.

My experience working on a state highway survey crew as an instrument man came in handy. But what I saw through my level was not reassuring. The upstream “control” that kept water from coming into town was a few piles of uncompacted dirt! There was no guarantee that these wouldn’t wash out and flood the town. As part of our flood fight effort the levee was properly wrapped around at the top end of the town side.

I remember looking through the level at the golf course that I was ensuring would flood first. I was a golfer. I visualized the sediment that would cover the course killing the grass and the floodwater that would damage the clubhouse and restaurant. I felt sick.

Ethical concept: Ethical decisions are not always easy.

Ethical concept: Ethical decisions require a balance between doing the greatest good for the greatest number while minimizing extreme harm to the lesser number.

Share Information with Authorities:

Another particular concern was an upstream diversion. This structure was diverting more than twice as much as it was allowing downstream to the town. It the diversion were destroyed, and all the water went downstream then catastrophic property damage and some loss of life would likely occur. The local law enforcement and I talked about this. Should someone threaten the structure, the authorities responding need to make an informed decision.

Ethical concept: Engineers need to share information with appropriate authorities about system sensitivity.

Check Computation Against Reality:

After the levee had been lowered, levee patrols were established, rock and sand bags were stockpiled, and city and county crews were trained to install filter fabric. I was feeling more confident. One evening my flood plain mentor and I were walking on the levee. I was expressing my confidence. He fell silent then said, “What if the model’s wrong?” I was stunned. That possibility had never occurred to me. The backwater model I computed matched calibrated flows and observed depths reasonably well. However, there was more to floodwater hydraulics than average depth. He threw a stick in the river, allowed a few seconds for the current to carry it and started pacing and timing with his watch. For the next several days I compared the velocities given by the computer printout to those observed in the river. There was more variation than I would have thought. As the weather got warmer and the runoff increased, I noticed another change. At first the current meandered more with each river bend. However, as the river rose and became faster, the current tended to go straight over longer distances. It also attacked the levee at new points. We had to dump rock on the river side of the levee to prevent erosion failure. As the water depth and velocity continued to increase the location of the attack points changed. This was not forecast by the backwater model.

Ethical concept: Engineer computer models and computations are only tools. Their results need to be checked against observed reality.

Less Precise:

At this point I would like to point out the variation in “precision levels” in some engineering areas versus others. Some fields of engineering are more of an exact science than others. For example, building a computer hard drive in a clean room is a much more exact science than estimating 100-year floodwater flood plains.

Ethical concept: The less precise the engineering is, the more ethical judgment is required to create a system that will work as needed.

Luck:

One Sunday afternoon I took some time off for nine holes of golf. The seventh hole paralleled the county levee. As I walked up the green I turned and faced the levee. There was a huge seep! I thought of running into the clubhouse and calling the work crew (we didn't have cell phones in those days), but just in played very fast. I got to the clubhouse phone and called the work crew foreman. He was at his son's birthday party and wondered if it couldn't wait until tomorrow. I was silent for a moment and then asked him, "Did you buy him a boat for his birthday?" About an hour later the whole crew showed up. When they saw how bad the seep was no one complained about spending their Sunday working. They installed filter fabric toped by dirt over the top of the seep and the problem was solved.

Mother Nature cooperated during the runoff season. At first the weather warmed-up and the runoff was near system capacity. Then we had a spell of cool weather and flows went back down. Again it warmed up and flows got near capacity. The temperature cooled once more and we dodged another bullet. Finally, it heated up and stayed hot, but by then so much of the snow pack had run through the system that we were able handle the remainder without any problem.

Ethical concept: Our outcome may be determined by luck.

Ethical concept: The Herculean efforts by county and city crews to remove logs from bridge openings enabled the system to function as designed.

Sometimes we think of maintenance as a before or after event, but with flooding maintenance is most critical during the event.

Unethical:

I mentioned that the less precise the discipline the more ethical judgment is needed to create a functioning system. Now we will look at some unethical engineering jobs.

We let a flood plain computation contract to a large Architect-Engineering firm. It was a model for unethical behavior. The principals of the firm showed up in their expensive suits, with many degrees, appropriate corporate resumes, and charm. They were all smiles while they negotiated the contract. We never saw them again. They dumped the job on some young engineer with a PhD. His book learning was only marginally up to the task of unconfined flood plain analysis. Moreover, they didn't give him enough time to properly do the job. When I saw the flood plains, I knew they were wrong. I took them back to him. I showed him what was wrong. He denied it. I then showed him his own photographs of street flow taken during a rain storm that proved what I was saying. He said, "That job's over. We've been paid for it." I then reported back to my own organization (this project was no longer under my mentor) and eventually wound up spend a long month with considerable overtime correcting their work.

The sequence of events for unethical engineering contacts frequently includes these steps.

1. A charming pitchman who will say whatever it takes to get the job.

2. A strong attempt to "charge what the market will bear". (Imagine if your grocer varied his prices according to how hungry you were in the checkout line.)

3. Delegating the job to an untrained under-resourced subordinate. (Key concepts here are to "treat employees like cattle" and "any warm body can do this".)

4. Closely monitor the subordinate's expenses while completely ignoring job quality.

5. Keep looking for another mark.

The employee of that firm used his employer's unethical model to form his own firm. He learned it well. He landed one job with our firm in the morning and later that afternoon we received a call from his secretary. She was crying. He had come in and thrown the hydrology manual at her and said, "You figure it out!" She wasn't an engineer and wanted to know if we could help her. I called her employer back and told him that the Corps negotiated for a journeyman engineer to do the job, not a secretary.

Fortunately, most firms are ethical. I dealt with one that did excellent work. When I found an error, they corrected it (even after they had been paid). Eventually I hired their most experience engineer to work for me. He was about 20 years older than me and had a wealth of career experience.

Ethical Concept: Charm and credentials are no substitute for competence.

Wall of Water:

One hydraulic concept I learned about was the wall of water. I had heard about such things, but always doubted their existence. One day I was near a large concrete channel and heard the sound of scrapping metal. I went over to the channel and observed a white clothes dryer lying on its side. There was nothing else in the channel. The noise sounded like it came from the dryer, but I could see no evidence of anything to move it. While I was standing there a wall of water about 6 feet high came down the channel and pushed the appliance on the concrete making the scrapping sound. I was stunned. The wall had a base about 3 feet wide which tapered up to the main part of the wall which was about a foot-and-a-half wide. The top 3 feet of the wall was a uniform width of about a foot-and-a-half wide. After about a minute another “wall” came down the channel. It was about the same size as the first. When I looked upstream, I saw 3 more “walls” coming at us. What I had witnessed was “slug flow”. (Please consult a hydraulics book for more detail.)

Walls of water can be made other ways. One small watershed had flooded and dumped considerable mud on local business. We found tin cans in the watershed that gave us an excellent geographic definition of the storm. We had eye witness accounts of when it started and how long the intense period lasted. I took cross sections with easily visible high-water marks. I used Manning’s Normal Depth equation to determine that the channel had carried 2,500 cfs (cubic feet per second). The hydrologist determined that the maximum flow should have been only 380 cfs with normal losses for infiltration. Even without any losses the model gave a peak flow on only 480 cfs. The observed flows were 5 times greater than the computed flows! This illustrates the phenomenon of “bulking”. Bulking is where mud and other debris swell the clean water. I have heard of bulking factors mentioned as high as two (and once even three). So this is more than just bulking. What happens is that the flood wave pushes debris out in front of the flood wave causing a dam (or wall) at the front of the wave. Also, the factor of channel bed friction being greater than “water on water” causes the bottom of the flood wave to be slower than the top. This creates a small dam with water flowing over the top. All of these factors conspire to create the wall of water.

I did another flood investigation on a military base that had suffered a 10-inch rain. Most of the drainage ran through a temporary road bridge. One young military policeman spotted a family stranded out on the structure and radioed that he was going out to help. The radio message was taped. His next and final comment was about a “huge wall of water”. All were washed from the bridge. There were no survivors.

My original belief of questioning the existence of the wall of water was based on uniform steady state open channel flow and the fact that I had never met anyone who had actually seen a “wall”. Today most design is based on the same assumptions. This means that some bridge openings may be undersized.

Ethical concept: The engineer is responsible for creating structures that work, not just following published design criteria.

Ethical concept: Make allowance for unusual challenges

Absence of Precise Evidence:

Sometimes we just can't tell exactly what happened. I was sent to the field to investigate a bridge collapse (it wasn't one of ours) that resulted in one fatality. The family of the deceased was considering suing. The central pier had been undermined. The family contended that the pier should have been designed deeper. The highway had once been a major traffic carrier but was now replaced by the interstate. As a parallel frontage road carrying relatively light traffic the road was certainly up to standard generally. The bridge was old and had withstood many decades of flooding, so there was nothing weak about this structure. The question then became "was the size of the flood over the design limit?". However, it was impossible to determine the size of the flood because I didn't know how deep the water was in the channel during the flood. With most overland floods the ground doesn't erode much at first so the flood can be analyzed using the existing ground line. However, this flow was in a confined rectangular arroyo. The high-water mark was only a few feet from the top of the channel sides. I looked at the rocks in the stream. They had a fresh disorganized look. The stream had a relatively constant slope so the old adage "the river brought it down, the river will take it away" was operating. I looked at the considerable delta of deposited material where the stream opened up in a farmer's field downstream from the bridge. This told me at the peak flow the ditch had an eroded bottom (which means the cross-sectional area greater than would normally be viewed on a "dry" day). The rocks flowing with the water would strike the pier with no small force. I conclude that no exact measurements were possible, the flood that destroyed the bridge was very large and that there was no evidence that pier was undermined at some "small flow".

Ethical concept: In the absence of precise evidence one must use judgment and experience.

System Sensitivity:

The field of floodwater engineering involves developing values with a wide standard deviation. For example, frequency analysis of data from a river gage may have 90% confidence limits that vary by an order of magnitude!

Using the 100-year rainfall to determine runoff is subject to some statistical error in determining the 100-year rainfall, another error in applying it uniformly to the basin in question, and even a greater error by assuming normal watershed infiltration (as opposed to a basin that has just been scorched by a fire).

The key to working with wide variation answers is to consider the impact on the drainage system if one of the answers turns out to be lower than the one Mother Nature might give us. Sometimes extra flow is not a problem and other times it is deadly.

Ethical concept: Engineering computations with large standard deviations need to be applied considering the sensitivity of the system.

Questions to Consider – 2nd Hour

There is frequently more money and glory in structural solutions that natural ones.

Does your organization favor expensive concrete structural solutions over natural flood plain zoning ones?

Is there anyone in your organization that can analyze "outside the box channel"?

The project management model is a strong one, but it tends to promote sales over technical knowledge.

If you are part of a large organization does your group encourage development of technical experts?

In what work situations would you be responsible for making engineering decisions that consider loss of life or catastrophic property damage as parameters?

Lowering a levee to get it wide enough to drive trucks on is counter-intuitive to the flood overtopping model that the public has. Once they understand that the trucks are needed to dump large angular rock at levee erosion points to prevent levee failure before the water ever gets to the top, public support is given.

Have you ever had to make a counter-intuitive engineering decision?

Have you ever had to sell that decision to public officials?

The reason that counter-intuitive concepts are in a course on ethics is that the ethical choice can be a counter-intuitive one. It is much easier to go along with popular delusions than have the strength of character to say "No".

In your own field how would you go about explaining your counter-intuitive idea?

The notion of equal protection under the law is a foundation concept in our legal system. It is one of the bedrock ideas that our culture is based on.

The basic idea that each individual is as important under the law and entitled to the same rights as anyone else is another good ethical idea.

However, ethics is a battle of good ideas.

We would like to protect everyone and we would like to do it equally. In every situation I would like to do so, if I could.

There are many levels of engineering ethical response. The simple one is the cost-benefit model we are all trained in.

Wise use of resources is another good ethical idea. Resources are not limitless. Resources get allocated considering property damage and loss of life. In low density population areas it is simply not cost effective to provide the same level of protection as in higher density population areas.

The notion of equal protection changes to equal protection per dollar spent to provide that protection. Equal protection per dollar is the quantitative application of the “greater good” ethical model.

Have you ever had to make decisions based on social good per dollar spent?

Most engineering decisions require some kind of cost-benefit analysis.

The decision is made for us. If there are more benefits than costs, then do it!

This is the first level of the “quantitative greater good” ethical model.

The second level of the quantitative greater good model is another offshoot of benefits per dollar. It involves grouping populations and providing more protection for the majority while minimizing the harm this causes to the minority.

This type of ethical decision is observed where large heavily traveled interstates have bridges that are designed for the 100-year frequency flood and many state highways are designed for the 50-year frequency flood.

Have you ever made a decision that favors the larger population group while providing less protection for a smaller group? How did you feel about doing this?

The third level of the "quantitative greater good" ethical engineering response is catastrophe avoidance. The emergency spillway on large dams is an example. The notch for the spillway lowers the volume the reservoir could hold but avoids catastrophic dam break by passing all flows safely.

In the flood fight example, the two different levels of protection provided by the two levees allowed a low population density to flood first and relieve some pressure on the system through town. This was a better alternative than having both levees with equal protection and having them overtop at the same time with catastrophic consequences.

Are you willing to sacrifice some protection for one group to avoid a catastrophe for both groups?

If we just follow the Code won't we be behaving ethically? Typically, many elements of all three levels of the "greater good" ethical model are in codes. However, care needs to be taken to be sure that all three levels are accounted for when planning or designing a project.

The 3 levels are: cost-benefit, big/little group, and catastrophe avoidance.

How does your job require you to deal with these?

Some situations are not covered by any written code. We looked at a case of a diversion that might be attacked and cause major damage or loss of life.

Are you willing to bring this to the attention of local authorities?

If asked are you willing to render your personal opinion as to a proper response by law enforcement officials?

If you are asked what would you say?

What if the model is wrong?

We discussed field tests measuring river current with a stick and stop watch. While the water surface level was closely predicted by the computer model, the impact points on the levee varied and were not discernible from the computer model.

Are you prepared to field check your work?

Are you willing to revise your technical opinion about the situation you are planning for?

Ethics versus Precision

Are you comfortable with the notion that the less precise the engineering is, the more ethical judgment is required to create a system that will work as needed?

We discussed a case where our largest emergency seep repair was based on a lucky observation.

Are you comfortable with the notion that the less precise the engineering is, the more likely our outcome may be determined by luck?

Summation of 2nd Hour

During the second hour we looked at the following ethical concepts:

- **Engineering decisions need to balance all risks, no matter how counter-intuitive.**
- **Ethical decisions are not always easy.**
- **Ethical decisions require a balance between doing the greatest good for the greatest number while minimizing extreme harm to the lesser number.**
- **Engineers need to share information with appropriate authorities about system sensitivity.**
- **Engineer computer models and computations are only tools. Their results need to be checked against observed reality.**
- **Our outcome may be determined by luck.**
- **The Herculean efforts by county and city crews to remove logs from bridge openings enabled the system to function as designed.**
- **Charm and credentials are no substitute for competence.**
- **The engineer is responsible for creating structures that work, not just following published design criteria.**
- **Make allowance for unusual challenges.**
- **In the absence of precise evidence, one must use judgment and experience.**
- **Engineering computations with large standard deviations need to be applied considering the sensitivity of the system.**

Ethics and Floodwater Engineering – 3rd Hour

In the third hour we will examine actual examples of ethics applied to planning floodwater projects.

Floodwater engineering is less well defined that most other engineering disciplines. Think of how many times the TV weather man misses a 24-hour forecast. Estimating the magnitude of an event that occurs once every century is even harder. The standard for many designs and for flood insurance is the 100-year flood. The 100-year rainfall may produce the 100-year flood. Estimating the 100-year rainfall and 100-year flood flow yields statistical confidence limits of considerable variation.

Rainfall amounts found in nature may not correlate with computed patterns. For example, the house where my wife and I lived for 30 years had a 100-year, 6-hour rainfall of 3.8 inches. Yet in the late 1980's we were at the center of thunderstorm that dumped 6 inches of rain on our property in much less than 6 hours. The runoff caused about a dozen homes to be flooded and killed one driver whose car was swept off a low water crossing.

Flooding can come from both hurricanes and thunderstorms. Hurricanes don't always keep moving. During the 1950's a hurricane stalled over the Pecos River south of New Mexico and dumped 30 inches of rain in about 3 days. This resulted in a flow estimated to be about a million cubic feet per second entering a downstream reservoir.

What is the floodwater engineer to do? The local design code may specify a 100-year design, but Mother Nature may have other plans.

Ethical concept: Mother Nature's plans may differ from design code.

The 100-year design has generally been accepted as a reasonable compromise between construction cost and public safety. I believe that 100-year is in the "good enough" category. While major roads have 100-year design, some minor roads could not be constructed at such a high level. So, some designs specify 50-year or less floodwater design criteria.

Ethical concept: Design and construct following code requirements but install overflow zones. For example, install a concrete channel to convey 10- to 100-year flows and then zone dirt areas adjacent to the channel to carry the 500- to 2000-year flows.

One problem with flood criteria being determined by population of users is that populations change. One of the scariest moments of my career occurred when I was on a field trip looking at a watershed I was about to code into a hydrologic model. As a youngster I had seen this area when it was low density farmland. Now I was looking at high density housing area. I walked the top of the dam above the houses. Suddenly I realized something was missing. The dam did *not* have an emergency spillway.

Dams need to have an emergency spillway to pass flows greater than the reservoirs holding capacity. If water flows over an earth embankment, it can erode the top of the dam and cause a catastrophic dam failure. Spillways are expensive, so in very low-density areas some agencies put earth-fill dams without spillways.

The Corps in cooperation with the city under the Corps Local Protection Authorities constructed a larger dam with an emergency spillway.

Ethical concept: Existing flood control structures need to be reviewed by local authorities at least once every decade to ensure changed urban conditions haven't rendered a floodwater project non-functional or even dangerous.

Please note that I refer to "local" authorities, because state authorities are frequently underfunded and may be more focused on private dams than those now located in newly created city limits.

The key ethical concept in floodwater management is to not increase existing runoff. It's that simple. If you increase floodwater runoff because you add impervious area by constructing buildings, sidewalks, or parking lots you have an obligation not to dump that on your neighbors.

If you increase impervious area then you need to add floodwater storage to offset your increase. Code usually requires using the 100-year frequency rainfall. Excess runoff is computed by subtracting pre-project runoff from post project runoff. Using the 100-year storm is an economical compromise between construction cost and downstream flooding from rare events that exceed the 100-year storm.

There is one other way to negatively affect your neighbors and that is by re-grading your yard so that the drainage is leaving your yard in a different direction, different location, or different elevation. How do you tell if it is significant? If your neighbor complains it is significant. If your neighbor even questions it, it is probably significant. I remember seeing a home remodeling show where the super-competent cast attempted to dump excess drainage in a new location that affected an adjacent neighbor. The whole scheme was so sleazy and totally beneath the outstanding craftsmanship they normally practiced. The neighbor complained and they had to do the job over instead of doing it right in the first place (like they almost always do).

At the 100 home construction site I mentioned in the first hour we had a downpour. The drainage from one back yard started spilling sideways into another backyard and they both spilled sideways into a third back yard which then spilled into a forth back yard. The owner of the fourth yard complained to me. The subs involved agreed it wasn't right. We got a small dozer and re-graded all four lots to drain into the street. No money exchanged hands. No plans were consulted. No reports filed.

Ethical construction = Problem Solved

Ethical concept: Do not increase the floodwater exiting your property.

Letter Vs. Intent:

One challenge engineer sometimes have is to decide between the letter of the law and the spirit of it. By "spirit" I mean "intent" of law and policy makers. One case I was involved in was the 100-year flood plain in a mountainous area. Paleo-hydrologic analysis showed that this watershed did not currently produce significant flooding (at least in the 100-year range), so the analyst suggested that the computed 100-year flood plain be radically reduced.

At the time I was coding a hydrologic model for a flood warning system and had analyzed the famous October 1918 storms which showed that runoff corresponded to the width of the stream plus 7-feet on each side. (This corresponded to researcher observations from that period.)

We talked and I pointed out that there was no doubt that he was technically correct for the exact 100-year flood plain (it would be just slightly higher than the 2-year flood plain), but that it would be *ethically wrong* to change from the computed flood plain because the intent of the law is that the 100-year flood plain is only slightly below the 500-year flood plain. For some rainfall above the 100-year event, the entire watershed would contribute. If we followed his suggestion then we would have houses located very near the creek and these would then be subject to catastrophic flooding and large loss of life when the 500-year (or some other frequency over the 100-year flood) happened. We stayed with the more conservative flood plain.

That discussion was in the latter half of the 1980's.

In 2013, forest fires altered the basin runoff characteristics. Suddenly, even 1 to 2-inch rains produced flooding in communities below.

At least there were no houses in the upper watershed located next the creek.

There is no practical way that law or policy makers can anticipate every unique situation. Theoretically, we could go to the courts and have them decide. But *before* we go to another decision maker, engineers frequently have an opportunity to meet with technical specialists and make speedy, timely, and informed decisions that are in the best interest of the public.

Ethical concept: Engineers need to consider the intent of Code, not just the letter of Code.

While I was working for the Corps of Engineers planning flood control projects before the later-1970's meant building dams and channels big enough to hold what was called the "standard project flood" (SPF). The SPF was typically the largest flood of record that happened in the vicinity of the watershed in question. SPF is a very conservative design.

If you ever think some flood control projects look bigger than others, it is because some are bigger. Most cities used much lower criteria than SPF.

When I joined the Corps in 1972 we used hand calculations, a few desktop calculators that could add, subtract, multiply, and divide, a very primitive mainframe computer with paper tape input, and a slide rule. By the later 1970's computer advancements made it possible to perform hydraulic and hydrologic computations much faster. This allowed for creation of many computer runs at various frequencies of flow; something that would have been far too costly with older technology. The more efficient technology facilitated the National Economic Development (NED) guidelines that tried to optimize the cost/benefit ratio. The idea behind NED was to optimize the nation's resources by investing only in the most efficient strategy as dictated by the cost/benefit ratio. This idea sounded good, but its application was not truly achievable.

The inflation of the late 1970's led to many interest rate hikes by the Federal Reserve Board. During the early 1980's a 30-year Treasury-bond interest reached a high of over 14%. The NED guideline for interest moved upward crushing hopes for any decent size flood control structure. The ethical dilemma faced by all of us was that flood protection was now being distributed on an inequitable basis. Consider the case of two identical communities who get dams built a few years apart. The community unlucky enough to get government authorization for its project during high rate years gets a much smaller dam and much less protection.

Additionally, a second major problem surfaced. That was the notion that we could determine future land and property values with any accuracy. Back in the late 1950's our organization justified building a large concrete channel to protect valley farm land below a rapidly developing city. That land was worth $20,000 to $30,000 per acre for much of my career. However, two gentlemen involved in benefit computation had a serious disagreement. One thought the other was crooked because he placed a value of

$500 per acre, when in fact he knew it was only worth $100 per acre!

During the first hour I brought up the notion that ethics is a "battle of ideas about what is good". The 100-year dam, channel, and levee system avoid flood insurance for those protected by them. There is pressure from land developers to at least protect to the 100-year level. SPF projects cost a lot more and provide benefits that are discounted deep in the future. What I saw justified for the rest of my career were 100-year structures with favorable benefit/cost ratios.

Do we have it right with 100-year structures? I don't know. There are cases where the government is allowing people to reconstruct homes below the SPF high-water mark simply because they are above the 100-year computed flood plain. Many people feel uneasy about this.

What if Mother Nature doesn't agree with our 100-year flood computation?

The idea of SPF design is appealing to reduce catastrophic flooding, allow for some climate change, and provide a buffer for variations in materials, variations in construction technique, modeling errors, code updates, equipment malfunction, future growth variations, and challenging site requirements beyond those considered by design code.

Ethical concept: Ethics is a battle of ideas about what is "good".

Ethical concept: Allow for a historical modification of code. For example, use the computed 100-year flood plain for zoning until a larger flood occurs and then use the historical flood plain for zoning and rebuilding decisions.

Conceptual Floodwater Plan:

My all-time favorite assignment was doing the conceptual floodwater plan for the new growth area in one city. The state highway department was planning a road across the northern end of a city to link a state highway with city street near mountains. They compute the substantial runoff from the mountains and designed a series of culverts under the proposed state road. The problem came when owners of the undeveloped land that would be flooded by the culvert discharge threatened to sue. So, the state highway department modified their design by moving the culverts to a new location. The downstream owners at that location threatened to sue. So, the state highway department went to city engineering, who in turn went to the Corps of Engineers who had built many flood control works in partnership with the city. It came up to our office and landed on my desk because I had done other work in this area. Funding for the project was available and everyone was waiting. I had the use of a one tech for drafting and quantity computations. The urgency of my output was greatly communicated to me. We had a problem that required a solution.

Ethical concept: Define exactly what is needed from you. As an engineer your duty may just be a plan or even an idea. If you are the decision-maker, then a speedy decision that implements a "good plan" today may be worth more than searching for a "perfect plan tomorrow".

First, I computed pre-project hydrology and flood plains. The flooding was too widespread to just leave things in their natural state (my opinion based on over a decade of experience).

Ethical concept: Ideas about "right" usually originate with one person. If the situation is urgent and your idea is in the "good enough" category, then go with your idea and move the next step.

We needed a flood protection system (again my opinion). First, I tried a large dam, but the reservoir pool flooded too much land in my opinion.

Then I tried a large conveyance channel. It ran many miles from the mountains down to an area outside the city limit. I honestly expected this to be the big winner. But I got a big surprise. The channel got bigger and bigger with every mile downstream. By the time it reached the bottom it was enormous and very expensive (my opinion again). So, I kept looking.

I decided on a small dam to capture the mountain flows. This radically reduced the size of the upstream channel. This greatly reduced the cost because the upstream slope was steep enough to require a concrete channel. The lower half of the channel had a slight slope that allowed us to use a dirt channel. The channel intersected other flow that I routed with levees to a sump. The sump was a dry desert lake bed that we took borrow out of to make storage for the 100-year flood. Adjacent to the intersection of the flow, I zoned a multi-purpose area for a golf course overflow area. This plan had a much lower price tag.

This was just a conceptual plan study, so I avoided time-consuming useless refinement and used hand calculations and approximations in lieu of detailed computer modeling. I computed 100-year and Standard Project Flood layouts, computed cost estimates, and presented the results. The mayor looked through the plans and selected the 100-year version with the lowest price tag.

I created a detailed hydrologic model for the selected project to determine design flows and volumes. The project construction (including a 27-hole golf course) was completed by the early 1990's.

Ethical concept: Avoiding useless refinements will save time and money. The job requirements should determine the level of detailed analysis used in a floodwater engineering study. Planning requires a less detailed effort than final design.

Questions for Consideration – 3rd Hour

Imprecision:

Note that weather information sites are challenged to forecast the presence of tomorrow's moisture, not its amount. Forecasting the amount for 100-year event is an incredibly imprecise art form.

Do you have any imprecise parts in your engineering field?

Smoothed Over:

Counter examples to theory exist. I described the 6-inch rain I experienced and also a stalled hurricane that dumped 30 inches. These are just "smoothed over" with statistical techniques.

Do you ever get the intuitive feeling that "smoothed over" statistics may not be in your best interest?

Which of the following best typifies your approach to discrepancies between code and observed reality?

A. Not my job.

B. Consider system sensitivity to increased challenges

C. Responsibility belongs to code writers

D. Designing for averages is fine by me

Partner Structural Zoning:

The 100-year design has generally been accepted as a reasonable compromise between construction cost and public safety. I believe that 100-year is in the "good enough" category.

However, we could install a concrete channel to convey 10- to 100-year flows and then zone dirt areas adjacent to the channel to carry the 500- to 2000-year flows.

What is your opinion about such a "graduated system"?

Review Existing Structures:

One problem with design criteria being determined by population is that populations change.

Spillways are expensive, so in very low-density areas some agencies put earth-fill dams without spillways.

Do your local city authorities review existing structures to ensure changed urban conditions haven't rendered a floodwater project non-functional or even dangerous?

Ethical Urban Runoff:

The key ethical concept in floodwater management is

A. Not increase existing runoff

B. Increase existing runoff

C. Live on a hill and not worry about runoff

D. We are in a drought. It doesn't rain here anymore. Do I have to answer?

Personally, I practice C, but we can't all live on hills connected by bridges. The correct answer is A.

If you increase floodwater runoff because you add impervious area by constructing building, sidewalks, or parking lots you have an obligation not to dump that on your neighbors.

Code Intent:

We discussed a situation where the 100-year flood plain was technically only slightly above the 2-year flood plain and very far below the 500-year flood plain. Normally the 100-year is far above the 2-year and close to the 500-year flood plain. The currently computed flood plain that was near the 500-year level prevented development near a creak. It would be *ethically wrong* to change from the computed flood plain because the <u>intent</u> of the law is that the 100-year flood plain is only slightly below the 500-year flood plain.

In 2013, forest fires altered the basin runoff characteristics. Suddenly, even 1 to 2-inch rains produced flooding in communities below.

At least there were no houses in the upper watershed located next the creek.

We will now take a couple of minutes for you to consider the next question in depth.

Think carefully about your job and your organization. Is there some part of your work in which you or some other employee should be considering the intent of Code, not just the letter of Code?

Interest Rate:

We saw how the more efficient technology (computers) facilitated the National Economic Development (NED) guidelines that tried to optimize the cost/benefit ratio. The idea behind NED was to optimize the nation's resources by investing only in the most efficient strategy as dictated by the cost/benefit ratio. This idea sounded good, but its application was not truly achievable.

The inflation of the late 1970's led to many interest rate hikes by the Federal Reserve Board. During the early 1980's a 30-year Treasury-bond interest reached a high of over 14%. The NED guideline for interest moved upward crushing hopes for any decent size flood control structure. The ethical dilemma faced by all of us was that flood protection was now being distributed on an inequitable basis. Consider the case of two identical communities who get dams built a few years apart. The community unlucky enough to get government authorization for its project during high rate years gets a much smaller dam and much less protection.

Do you believe that current interest rates should have a major impact on the size of a community's flood protection?

Do you feel that this is ethical?

Future Property Value:

Additionally, a second major problem surfaced as we attempted to employ the cost/benefit computation of the National Economic Development Act. That was the notion that we could determine future land and property values with any accuracy. We discussed an example that showed how difficult land estimation was in practice.

Do you believe that flood control protection should be strictly based on future estimates of the value of property protected?

Building Below Flood of Record:

The 100-year dam, channel, and levee system avoid flood insurance for those protected by them. There is pressure from land developers to at least protect to the 100-year level, but no higher because it consumes developable land. What I saw justified for the rest of my career were 100-year structures with favorable benefit/cost ratios.

There are cases where the government is allowing people to reconstruct homes below a real flood high-water mark simply because they are above the 100-year computed flood plain. Many people feel uneasy about this.

What if Mother Nature doesn't agree with our 100-year flood computation?

How do you feel about allowing for a historical modification of code to use the computed 100-year flood plain until a larger flood occurs? Then use the new historical flood plain for zoning and rebuilding decisions. Is this an idea you could support?

More is the Enemy of Enough:

We looked at a conceptual floodwater plan I did. I avoided excessive design refinements in the planning phase. I could have done <u>more</u> detailed, but it would have taken too long. I had the right idea and construction proceeded quickly.

In your firm do you have cases where "more is the enemy of enough"?

In your job do you have the freedom to make decisions about what is "right"?

Are you allowed the creative freedom to propose creation of a multipurpose structure like a golf course in a flood plain?

Summation of 3rd Hour

In the third hour we applied ethics to planning. Ethical concepts drawn from the examples are:

- **Mother Nature's plans may differ from design code.**
- **Design and construct following code requirements but install overflow zones. For example, install a concrete channel to convey 10- to 100-year flows and then zone dirt areas adjacent to the channel to carry the 500- to 2000-year flows.**
- **Existing flood control structures need to be reviewed by local authorities at least once every decade to ensure changed urban conditions haven't rendered a floodwater project non-functional or even dangerous.**
- **Ethical construction = Problem Solved**
- **Do not increase the floodwater exiting your property.**
- **Engineers need to consider the intent of Code, not just the letter of Code.**
- **Ethics is a battle of ideas about what is "good"**
- **Allow for a historical modification of code. For example, use the computed 100-year flood plain for zoning until a larger flood happens and then use the historical flood plain for zoning and rebuilding decisions.**
- **Define what is exactly what is needed from you. As an engineer your duty may just be a plan or even an idea. If you are the decision-maker, then a speedy decision that implements a "good plan" today may be worth more than searching for a "perfect plan tomorrow".**
- **Ideas about "right" usually originate with one person. If the situation is urgent and your idea is in the "good enough" category, then go with your idea and move the next step.**
- **Avoiding useless refinements will save time and money. The job requirements should determine the level of detailed analysis used in a floodwater engineering study. Planning requires a less detailed effort than final design.**
- **More is the enemy of enough.**

Ethics and Floodwater Engineering – 4th Hour

In the fourth hour we will look at ethical considerations for inspections of completed flood control works and emergency management.

Ethical concept: An ounce of prevention is worth a pound of cure.

I wish I'd said this first, but Ben Franklin beat me to it.

This saying applies to inspection of completed flood control works and to emergency management. Why build projects that have problems and why have damage from natural phenomena?

For a dozen years I headed our local Corps District's Inspection of Completed Civil Works Program and was Chief of their Emergency Management Branch. Pairing these two was a good marriage. If unusually high water occurred, we heard about it through our emergency channels and could then see if which of over 130 projects might be damaged. The Corps built projects under many authorities, but most had the same characteristics of the local sponsor (city, county, state, flood control district) providing lands, easements, and rights-of-way: holding the federal government harmless; and sharing the cost. If the locals maintained the project in good condition (as determined by our inspection group), then in the event of a large flood that damages the project, the Corps will repair the damage. Almost all locals keep the projects in good shape, but it does help to remind them every year or two of their responsibility and minor deficiency that needs to be fixed. Most local maintenance consists of minor erosion repair, channel clearing, and weed and trash removal at inlets.

I saw something that bothered me. We kept making the same mistakes on the same rivers.

The problem was a lack of feedback. The lifespan of these projects we were constructing was 100 years. Human life spans are not that long and engineering careers are much shorter. If a young engineer with only 5 years of experience was given a bank protection project, he or she would likely have only another 30 years or so for that project to be tested. So, there was only about 1 chance in 3 that the engineer would ever get feedback during a career.

We needed some way to provide feedback to the planning department. We tried taking a few along on inspections, but most only saw a few projects. Also, seeing a project didn't tell you its history, or its strengths and weaknesses.

In the early 1990's the Corps embraced Total Quality Management in the form Total Army Quality. TQM was based on three concepts: do an action, observe feedback, make an improvement and then do a revised action, etc. My problem was that planning wasn't seeing the feedback we were experiencing in our inspections.

I got permission under TAQ to do a Lessons Learned program. I contracted with a hydraulics professor and a respected consultant. During the next five years we did a Lessons Learned on each project. I knew were the skeletons were buried and pointed them out to our contractors. I started with some of best projects so that people would like to read the reports and then slowly passed from the acceptable to the dubious. We also wrote a Best of Lessons Learned. Still I got the feeling that we hadn't communicated with new planners in a very efficient way.

I finally figured out a chart the might quickly "tell all". Listing the rivers in our district down the left of the page and types of bank protection across the top of two pages created a matrix. In each block was a circle that was clear for success, half black, or fully black for failure. Also, in each block was the page number from the report that gave the rating. For example, on one stream in our district every bank protection failed, except for extremely large rock. This told planners what they needed to do.

Ethical concept: Engineers who know history can plan better.

Sharing Information Helps Public Image:

As I was distributing the last report, I talked to one of the engineers. He hadn't seen any of the reports! I needed a better way to reach all the people and this new invention called the Internet might just be the way. With help from our computer folks, I got a computer firm to create a 7,000-page website. The data was scrubbed to eliminate any sensitive information. A giant map had hot links to navigate to individual projects. The website went public in 1999. It was popular in-house. I put a tracer on the email and found that all but 3 employees kept the email transmitting the website link. One key use was for identification of projects that the Corps had constructed many years ago, but that most employees did not know about.

The website was popular outside the Corps. Over the years I had talked to many environmentally interest people who didn't like our jetty jacks in our local river. They thought it spoiled the trees and sand beach areas. I then pointed out that the levees were there to prevent valley flooding and that the river threatened to erode the levees. So, we put jetty jacks to slow the water and allow it to dump some of its sediment load. This sand that was dumped formed the sand bars and sand beaches. Lastly, the cottonwoods started growing in the sandy areas. So, the jacks helped create the pleasant environment.

After the site went up, university students would call and ask informed questions. Their favorite publication was the "Best of Lessons Learned". No longer were we regarded with suspicion. It was a real pleasure to talk to an informed public.

Ethical concept: Sharing valid engineering application with the public enhanced our public image.

One thing I noticed during the first year was the absence of bad reaction to some of our unsuccessful bank protection projects. Owning up to past failures to improve future designs struck a positive note with the public.

On September 11, 2001 the government ordered all engineering data removed from the web. By the time I retired in 2003 I was starting to have the same old disappointing conversations caused by dealing with an uninformed public. The website continued to be used in-house.

Ethical concept: While education entails risk, there is a bigger risk in not educating.

Angry Victims

Next, we will deal with flood emergencies. I worked in the Emergency Management Branch during the last 14 years of my career and dealt with many flood victims before that.

Many times, we would get calls from angry citizens about their property being flooded and how they were going to march on the Senator's office if we didn't help them. Frequently, they had called three to five other people before reaching our area. They were angry. "Why did God do this to me? We go to church. We're good people."

Many times, flood victims are so angry they can't think straight. I've seen this irrational anger in the field when dealing with flood victims. I remember one house that was trapped between a levee and a road embankment when the flood wave rolled in. The water floated a partially full fuel oil tank causing the connecting pipe to break and stain the perimeter of the home. That was followed by cut hay floating in the water and sticking to the house. The house had been "tarred and feathered" and it still had a pond in the front yard. The lady inside saw me. Went to her porch and got into a row boat and paddled across her yard over to the road embankment where I had been standing. She calmly got out of boat and walked over to me and said, "I think I hate you." I found out that they got the animals to safety but weren't quick enough about moving all the automobiles to high ground.

Most of the time you can let them blow off steam and then start talking objectively. Fortunately, the Corps didn't have anything to do with that flood and ultimately we put in a large flood control channel that would protect against just such a flood as they had recently experienced.

Is there any other way to help a flood victim restore his or her objectivity?

Yes. One old timer taught me restore objectivity by asking, “Where are your children?” Invariably the person answers, “They are playing in the floodwater.” At this point we would explain “that floodwater is Mother Nature’s sewer system. It’s full of pesticide, fungicide, mine tailings, cow dung, and tetanus.” Immediately, the person forgets all the unimportant anger and starts thinking about what really counts.

Ethical concept: Our children come first. Everything else is a distant second.

The second emotional concept I would like to share with you is about emotional states of flood victims. There are dozens of emotions, but flood victims aren’t experiencing many of them. When flood victims are active enough to contact you, they are in three primary states: heroic, angry, or depressed. Note that some who are not contacting you may be in shock, injured, or paralyzed with fear.

Most rescues are by neighbors or family. Many of these are done by people in the heroic state. After the rescues, the heroic state usually subsides.

Flood victim emotional states are: heroic, anger, depression

I have only seen one case where the heroic state lasted for days. I received a call from a lady with a lilt in her voice while she explained that her land had been flooded and her house was in danger. I realized that she wasn’t angry or depressed. My first question to her was, “Has anything else happened in your life recently?” She responded with, “Oh, we buried my husband last Tuesday.” She was still in shock. I found out that she and her late husband had two children and had just purchased a small farm.

It was their dream place. I asked her where her two children were. Of course, they were playing in the floodwater. When she found out what was likely in that water, she snapped out of the heroic mode and became a practical parent. We talked for a while and I informed her that changes in regulation of a lake upstream would cause her land to flood more than in the past. We also talked about the difficulty of her working the land by herself. She realized she would have to sell. After the call, I called a local agency and talked to a person familiar with the situation and he said he would stop in the next day and check on her.

In this example, I moved the victim from the heroic state to the start of anger. I could sense the tears welling-up toward the end of our conversation. Unmet expectations cause anger. She and her late husband had planned an idyllic life together. She now had to confront the fact that their dream was dead and that for the sake of her children she needed to act quickly.

The best psychological article about flood victims I ever read was stated that the emotional objective when dealing with flood victims was to move them from heroic, to anger, to mild depression. I have never seen this model fail.

While our culture praises heroism, being in the heroic mode isn't very practical for day-to-day living because it is too risky. In the heroic mode people take extreme risks that are justified in extreme circumstances but are counter-productive in normal decision making.

Being angry can help us take action, but it's difficult to think clearly when extremely angry.

The best we can hope for is a mild depression. Note I am not taking about some paralyzing clinical depression. I am talking about disappointment that is so great you are forced to change your plans for the next year.

I know that our society holds depression in low esteem, but flood victims just aren't going to be happy. They may be relieved to have not lost friends, family members, or pets, but they are definitely not happy about being flooded.

I remember when I first heard the advice about moving the high esteemed hero state to the lowly depressed state, I didn't want to believe it. However, my experience with flood victims supports the notion of moving from hero, through anger to mild depression.

When flood victims are in a state of mild depression, they "own responsibility for cleaning-up their property". I remember one lady sighing and saying that "they had been planning to go to Hawaii, but that would just have to wait another year."

Once the flood victim is in the objective mild depressed state it is time to talk about removing all sheetrock up to (and a little above) the high-water mark in the house. The insulation behind the removed sheetrock also needs to be removed. The bed mattresses need to be discarded because they are full of contaminated water. Turn the power off and have an electrician check out your circuitry after it dries. Some things can be washed, but many should be discarded.

Ethical concept: During emergency situations the floodwater engineer needs to consider the emotional state of flood victims.

It is OK to ask for help:

It's ok to ask for help.

The generation of engineers before me built many projects. Most of those projects protected an ever-growing population. Growing populations mean more property is being protected and that increases benefits in the benefit/cost ratio. However, not every protected property grew in size or value.

We had several flood fights (one using prison labor) to save a levee protecting an old town. This levee had one extremely weak spot subject to bank erosion at moderate flows. I talked to one of the old timers and found out that they knew about that weak spot but couldn't afford to armor the bank with large angular rock because the additional cost would make the benefit/cost ratio less than one and that would kill the whole project. They knew that there would have to be a flood fight at that spot, but at least the locals would have a chance to avoid flooding.

The last flood did considerable damage to the levee and we needed a project to properly repair the damaged section and also armor it. The problem the Corp faced was that any repairs had to be added to the total cost of the levee and benefits would be based on the town's old depreciated buildings. Clearly the benefit/cost ratio for a Corps project wasn't going to happen.

What we needed was more money. I had met an individual who had some access to private grant funds. I called him and he said, "I'm on my way." The Corps was then able to repair the damaged levee and armor the vulnerable section as well.

Ethical concept: Don't be afraid to ask for help when it is for a good cause.

Acting Ethically

I have made the decision twice in my career to take action based on the possibility that slightly above normal rainfall could cause severe consequences.

As Chief of Emergency Management one of my duties was to do a quick hazard analysis every spring before the snowmelt runoff season began. I would ask myself "What's different?" I looked at our new construction projects. Most involved little or no increase in threat level. However, one year I noticed something very different. We were rehabilitating a levee directly across from very large drainage outlet that drained about twenty square miles of urban area. This is about the size of our larger thunderstorms. I started making inquiries. I found out that our specifications allowed the contractor to take down a mile of levee at a time! The contractor was also given two years to complete the job. This put an entire community at risk. I informed our District Engineer (a colonel) who did not like this vulnerability in his area. Ultimately this matter went to headquarters in Washington. This is always a little risk when raking down a poor levee to remake it with better materials and a better design. However, this was no small risk. I looked intently throughout our district streams and determined this was the only such situation we had. The reason this escaped the engineers doing a field review was that vegetation obscured a view of the outlet on the other side of the river. The reason I knew about it was that I had actually done some modification work on both projects in prior decades.

The contractor was informed of the danger, increased his effort, and completed the project in one year rather than the two years allowed by the contract.

Two things happened. First, I lost some long-term friendships by people involved in the project who felt that I had made them look bad. Secondly, it didn't rain enough that summer or the next to have made a difference.

Ethical concept: Doing the right thing isn't always popular or needed. But not doing the right thing could be a lot worse.

However, the second time I took action was different.

I participated in one very large emergency response in which a well-traveled road to a critical facility was in danger from ponded water piping through its embankment. A recent forest fire had increase runoff far above typical flows. It was thunderstorm season. The opening to the tiny drainage pipe through the road embankment had been buried in the mud. Our district with the aid of contractors responded by jacking a pipe through the embankment. At one point in the decision making the question was raised about which type of pipe. Concrete pipe would be more economical. I felt that time might be in short supply. I said "steel". We stayed with steel. I also went to every group and every person on the critical path of this project and ask for priority. They responded and several days were saved up front in the contracting and financial process. The construction began. The pipe was finally jacked through the embankment. That night we got a huge thunderstorm over the watershed in question. Estimates were that had we not had jacked the pipe through that day we would have had a record high pool against the embankment that would likely have failed the random fill structure.

Ethical concept: You don't always have "hard" data to base taking action on.

Final Ethical concept: "It might not rain" is a poor protective strategy.

My favorite quote about ethical solutions is, "One life that soon is past, only that made with love will last."

Summation of 4th Hour

Here is a summary of the ethical concepts covered in this hour.

From the inspection examples we saw that:

- **An ounce of prevention is worth a pound of cure.**
- **Engineers who know history can plan better.**
- **Sharing valid engineering application with the public enhanced our public image.**
- **While education entails risk, there is a bigger risk in not educating.**

From the emergency examples we noted:

- **Our children come first. Everything else is a distant second.**
- **During emergency situations the floodwater engineer needs to consider the emotional state of flood victims.**
- **Don't be afraid to ask for help when it is for a good cause.**
- **Doing the right thing isn't always popular or needed. But not doing the right thing could be a lot worse.**
- **You don't always have "hard" data to base taking action on.**
- **"It might not rain" is a poor protective strategy.**

Course Summary – Hour 1

During "Ethics and Floodwater Engineering" the benefits of being an ethical engineer have been explained using actual examples.

In the first session of we first discussed the definition of ethics, many perspectives of ethics, and the notion of situation ethics.

The notion of "good enough for all players" rather than favoring one special interest group was discussed.

Examples were presented that illustrated the desire by almost all of us to do right by society.

When faced with a design choice consider the more conservative option to protect you, society and our profession. Make it stronger than code and easier to construct.

No one knows the future so allow for future variations by designing for more than average conditions.

We looked at a case that illustrated the idea construction inspection firms must be paid directly by the customer and not by the contractor who is being monitored.

Lastly, we had an example of how being ethical empowers your subordinates.

Course Summary – Hour 2

During the second hour we examined situations that showed ethical decisions are not always easy.

We had one case with a levee lowering to fight erosion rather than the public perception of levee overtopping. Engineering decisions need to balance all risks, no matter how counter-intuitive.

We looked at situations illustrating the following concepts:

Ethical decisions require a balance between doing the greatest good for the greatest number while minimizing extreme harm to the lesser number.

Engineers need to share information with appropriate authorities about sensitive parts of the system.

Engineer computer models and computations are only tools that need to be checked against observed reality.

Our outcome may be determined by luck.

The Herculean efforts by county and city crews to remove logs from bridge openings enabled the system to function as designed.

Charm and credentials are no substitute for competence.

The engineer is responsible for creating structures that work, not just following published design criteria.

Make allowance for unusual challenges

In the absence of precise evidence, one must use judgment and experience.

Course Summary – Hour 3

During the third hour we dealt with ethics and floodwater planning. The following points were illustrated:

Mother Nature's plans may differ from design code.

Design and construct following code requirements but install overflow zones. For example, install a concrete channel to convey

10- to 100-year flows and then zone dirt areas adjacent to the channel to carry the 500- to 2000-year flows.

Existing flood control structures need to be reviewed by local authorities at least once every decade to ensure changed urban conditions haven't rendered a floodwater project non-functional or even dangerous.

Do not increase the floodwater exiting your property.

Engineers need to consider the intent of Code, not just the letter of Code.

Ethics is a battle of ideas about what is "good".

Allow for a historical modification of code. For example, use the computed 100-year flood plain for zoning until a larger flood occurs and then use the historical flood plain for zoning and rebuilding decisions.

Define what is exactly what is needed from you. As an engineer your duty may just be a plan or even to get an idea. If you are the decision-maker, then a speedy decision that implements a "good plan" today may be worth more than searching for a "perfect plan tomorrow".

Ideas about "right" usually originate with one person. If the situation is urgent and your idea is in the "good enough" category, then go with your idea and move the next step.

Avoiding useless refinements will save time and money. The job requirements should determine the level of detailed analysis used in a floodwater engineering study. Planning requires a less detailed effort than final design.

Course Summary – Hour 4

During the fourth hour we looked at the long-term benefit of feedback in floodwater engineering. The following ethical concepts come from that experience.

An ounce of prevention is worth a pound of cure.

Engineers who know history can plan better.

Sharing valid engineering application with the public enhanced our public image.

While education entails risk, there is a bigger risk in not educating.

Lastly in the fourth hour we considered some lessons learned from floodwater emergencies:

Our children come first. Everything else is a distant second.

During emergency situations the floodwater engineer needs to consider the emotional state of flood victims.

Don’t be afraid to ask for help when it is for a good cause.

Doing the right thing isn’t always popular or needed.

You don’t always have “hard” data to base taking action on.

“It might not rain” is a poor protective strategy.

The key concept for employing ethical solutions is knowing when to start looking for them. When the Code or “book” does not match the reality you are dealing with then it time to ask the question, “What is the right thing to do?

This concludes the course “Ethics and Floodwater Engineering”.

Ethics and Floodwater Engineering

4-Hour

Quiz Problems

1. Engineering Ethics are useful to bridge the gap between:
    A. Money and power
    B. Reality and Code
    C. Right and wrong
    D. Law and Reason

2. Less precise forms of applied science can benefit from:
    A. Ethical perspectives on error tolerance
    B. Good Luck
    C. Both A and B
    D. None of the above.

3. “Error tolerance” refers
    A. Unexpected end-user behavior
    B. Unique site requirements
    C. Manufacturing errors
    D. All of the above.

4. The engineer’s responsibility is to:
    A. Make the system work
    B. Make as much money as possible
    C. Have fun at work
    D. Be popular

5. The journey between the black and white world of “by the book” and system reality can be aided if the engineer asks what question
    A. What strategy will make my firm the most money?
    B. What is the right thing to do?
    C. Who can I dump this difficult job on?
    D. Will “Flood Plains for Dummies” help?

6. Ethics are:
    A. Bad for business
    B. OK taken in small doses
    C. Moral principles that govern the behavior of an individual or group.
    D. A conundrum

7. Engineering ethics sets the obligations by engineers to:
    A. Make a smaller profit than they had hoped on this job
    B. Themselves
    C. Minimizing client costs
    D. Themselves, their clients, society and to the engineering profession

8. "Situation ethics" is:
    A. A judgment based more on the context of a situation rather than absolute moral principles
    B. Whatever we want it to be
    C. A judgment consulting absolute moral principles
    D. Flexible judgments to maximize my income

9. Ethics is a battle of ideas about:
    A. Optimization
    B. Good
    C. Profit
    D. Effort

10. Who do ethical considerations involve?
    A. The engineer personally
    B. The engineer's client
    C. All of these
    D. Society

11. One of the problems with ethics is
    A. I can't afford them.
    B. I will feel guilty if I "charge what the market will bear" instead of time plus a reasonable profit.
    C. People take advantage of me when I am ethical.
    D. I feel confused. There are so many different perspectives to view things from.

12. When formulating an ethical strategy, the emphasis should be on
    A. Finding a plan that is "good enough" for all the players
    B. Finding a plan that is best for all the powerful and popular players
    C. Finding a plan that is best for me
    D. Doing it to them before they do it to me

13. According to game theory how many variables can we maximize at one time?
    A. As many as we like
    B. One
    C. Three, if we use a 3-dimensional graph
    D. Group theory has superseded this branch of mathematics.

14. Do unethical people eventually have any problems?
    A. Not if they keep moving
    B. Not if they avoid those who really know their character
    C. A tarnished reputation may result
    D. Charm conquers all

15. No craftsman likes to do
    A. Work in the rain
    B. Good work
    C. Overtime during the Super bowl
    D. Substandard work

16. Unethical people can be
    A. Any of these
    B. Evasive
    C. Practiced at bait and switch
    D. Lacking in respect for the law or social customs

17. Unethical clients may want to
    A. Have the engineer build project the too cheaply.
    B. A, C, and D
    C. Blame the engineer when an underfunded project fails.
    D. Use the property for activities for which it was not designed.

18. Which of the following should an engineer do?
    A. B, C, and D
    B. Design to the maximum allowed by code to save the client money.
    C. Make it stronger than code and easier to construct.
    D. Subcontract difficult or unpleasant jobs.

19. You are coding a hydraulic computer model. The bridge data you are inputting is for a two 4'x4' box culvert. The flow area in square feet is
    A. 32
    B. 64
    C. 48
    D. 28

20. Contractor monitoring firms should be paid
    A. Directly by the customer
    B. Directly by the contractor
    C. Directly by the government
    D. All of the above

21. Which of following is false?
    A. Being ethical empowers your subordinates.
    B. Ethical decisions are easy.
    C. Engineering decisions need to balance all risks, no matter how counter-intuitive.
    D. Ethical decisions require a balance between doing the greatest good for the greatest number while minimizing extreme harm to the lesser number.

22. Which of the following is true?
    A. Engineers need to share information with appropriate authorities about system sensitivity.
    B. Engineer computer models and computations are only tools that need to be checked against observed reality.
    C. A, B, and D
    D. The less precise the engineering is, the more ethical judgment is required to create a system that will work as needed.

23. When acting ethically in a particular situation the outcome
    A. Is a near certainty
    B. Is likely to be favorable
    C. Is likely to be unfavorable
    D. May be determined by luck.

24. Which of the following are ethical concepts?
    A. The Herculean efforts by county and city crews to remove logs from bridge openings enabled the system to function as designed.
    B. Charm and credentials are a balanced substitute for competence.
    C. The engineer is only responsible for following published design criteria, even if the system fails.
    D. Avoid make allowances for unusual challenges that are expensive.

25. Ethical concepts about system sensitivity include:
    A. None listed
    B. C and D
    C. In the absence of precise evidence, one must use judgment and experience.
    D. Engineering computations with large standard deviations need to be applied considering the sensitivity of the system.

26. The idea of a benefit/cost ratio greater than one is a good idea since it spends the taxpayer's money beneficially. However, this policy results in the government offering flood protection to legal businesses engaged in gambling and prostitution, while failing to provide flood protection to poor farm families living in cheap adobe housing because the benefits are so low that the benefit/cost ratio is less than one. Ethical actions include:
    A. Offer job training so the farmers can become card dealers.
    B. Sometimes you just have to "hold your nose" and follow the rules.
    C. Find some grant money to help the farmers.
    D. None of the above.

27. Sometimes rainfall radically exceeds the design rainfall. One way to allow for this is to
    A. Pray
    B. Live near the top of a hill and watch the flood go by.
    C. Develop the land fully and then leave the area quickly. The trick is not to play the game too long.
    D. Design and construct following code requirements but install overflow zones. For example, install a concrete channel to convey 10- to 100-year flows and then zone dirt areas adjacent to the channel to carry the 500- to 2000-year flows.

28. When population density goes from rural to urban that will
    A. Require dams to have emergency spillways
    B. Require no action
    C. Be OK as long as the new neighbors don't dump additional drainage on the old neighbors.
    D. Not change the flood plain

29. The Code specifies an exact frequency, but this system is very sensitive near that frequency. Events at the Code frequency are miniscule. Events somewhat beyond the Code frequency are catastrophic. You should:
    A. Follow Code to the letter.
    B. Consider the intent of the Code, not just the letter of the Code.
    C. Move off this potentially controversial job.
    D. Write Higher Authority for guidance.

30. Most Codes get updated to reflect changes in the industry. When Mother Nature offers us a change we should:
    A. Ignore it as a statistical fluke. We understand weather completely and got it right the first time around.
    B. Consider current real estate interest ahead of abstract "future public good".
    C. Use the computed 100-year flood plain for zoning until a larger flood occurs and then use the new historical flood plain for zoning and rebuilding decisions.
    D. Stay with the old flood plain to save taxpayer money by avoiding the expense of drawing new flood plains.

31. You are assigned a conceptual planning study. Time is in short supply. You should
    A. Use the same techniques that you use for final design even though they are much slower and more expensive.
    B. If the situation is urgent and your idea is in the "good enough" category, then go with your idea and move the next step.
    C. Avoiding useless refinements will save time and money. The job requirements should determine the level of detailed analysis used in a floodwater engineering study. Planning requires a less detailed effort than final design.
    D. B and C

32. With the advent of Global Positioning Coordinates (GPS) river bank erosion projects can now be designed to the nearest foot and then be appropriately constructed as the plans show.

A. Not true because bank erosion will continue during the design process and the construction staff will have to use some judgment about the final placement.
B. True because constructors should always follow the designer's lead.
C. Of course, we will build it exactly like the plans show. Why wouldn't we.
D. Good idea so we can save money on field staff positions by hiring the youngest cheapest inspectors possible.

33. Widespread studies of levee bank erosion are important because
A. While education entails risk, there is a bigger risk in not educating.
B. A, C, and D.
C. Sharing valid engineering application with the public enhanced our public image.
. D. Engineers who know history can plan better.

34. Which of the following is true about natural emergencies?
A. During emergency situations the floodwater engineer needs to focus on technical details with little concern for the emotional state of flood victims.
B. Most children are good swimmers, so we don't have to worry much about them.
C. An ounce of prevention is worth a pound of cure.
D. It's too big for any one person to make a significant difference.

35. When you have a chance to prevent a possible disaster you should:
A. Lie down quietly until the urge to do anything passes.
B. Depend on a Higher Power to keep it from raining.
C. Avoid upsetting other people by asking them for help.
D. Recognize that doing the right thing isn't always popular or needed. But not doing the right thing could be a lot worse.

36. Being an ethical engineer means
A. You won't always have "hard" data to base taking action on.
B. You will always do the optimal thing.
C. You will be popular and respected.
D. A and C