Engineering Ethics

Ethics is fundamental to engineering.

Ethics and ethical reasoning are vitally important in engineering.

Why?

Decisions made by engineers usually have serious consequences to people.

Ethics and ethical reasoning guide decision-making.

Consider the results of the March 11, 2011 8.9 magnitude earthquake near Sendai, Japan.

The damage to the Fukushima I Nuclear Power Plant (*Fukushima Dai-ichi*) has led people worldwide to rethink the ethics of nuclear power.

Notice the issues that come up in these discussions:

ISSUE #1: HEALTH AND SAFETY

RISKS: Danger to current and future generations from leakage of radio-isotopes used in nuclear power.

A particularly toxic radio-isotope is Plutonium-239 (half-life = 24,110 yrs) Normally, 10 half lives are required before a Pu-239 contaminated area is considered safe again, in the case of plutonium, roughly 250,000 years.

So if Pu leaked, -- say, due to an earthquake -- it would cause a health risk for roughly 8000 generations!!

Notice the issues that come up in these discussions:

ISSUE #1: HEALTH AND SAFETY RISKS, FURTHER CONSIDERATIONS:

a) The possibility of medical science discovering a cure for cancer sometime in the current or next centuries qualifies the long-term health risks of leakages of radio-active isotopes.

Notice the issues that come up in these discussions:

ISSUE #1: HEALTH AND SAFETY RISKS, FURTHER CONSIDERATIONS:

b) The use of nuclear power may increase our knowledge of radioisotopes used for medical purposes.

Notice the issues that come up in these discussions:

CONSEQUENCES OF ALTERNATIVES TO NUCLEAR POWER.

ISSUE #2: DEPLETION OF RESOURCES:

Fossil fuels, oil, natural gas and coal, are non-renewable. These sources also affect the goal of *health* through pollution and climate changes.

Notice the issues that come up in these discussions:

CONSEQUENCES OF ALTERNATIVES TO NUCLEAR POWER.

ISSUE #3: COMPARATIVE ECONOMIC COSTS OF RENEWABLE SOURCES.

Renewable sources **such as hydro-electric-power, wind power, solar power, geo-thermal heat, agricultural biomass and tides do not cause the environmental hazards that fossil-fuels do.**

But renewable sources must be balanced with the amount of energy needed to produce and maintain them and consequent environmental hazards. Currently, for example, the energy required to manufacture and install solar energy systems comes from fossil fuels.

If you look carefully at the kind of reasoning that goes on in such discussions, you'll find that it involves certain *goals* such as, in this case, health, safety and bio-diversity. The reasoning then focuses on finding the best – or at least the reasonably better -- *means* for obtaining those goals.

This type of reasoning is often called _practical reason_.
It uses different methods from mathematics and the sciences.

Ethical reasoning is a type of practical reasoning which concerns in particular certain societal or life-form goals, such as justice, equality, freedom, health and safety.

Consider how practical reasoning operates differently from theoretical (scientific and mathematical) reasoning.

Take a simple case:
Say you have a cold.

You have some hot chicken soup?

What do you do?

Notice that there is not an overriding principle or theory involved, but a *goal*, in this case *health* and a *means*, chicken soup.

Specifically, we have no overriding theory that explains exactly how the chemistry of chicken soup effects the enzymes and anti-bodies so as to speed up the recovery from a cold.

But nonetheless chicken soup speeds up the recovery from colds.

Again, the lack of an overriding *principle, law* or *rule that provides an exact and unique* answer doesn't mean that there is

no

reasoning involved.

First we need distinguish between law and ethics.

**Law, as ethics, is also based on *practical reason*, but the justification for law is different from ethics.**

Laws sometimes remain enforced when they are not ethically justifiable.

As a result law and ethics may conflict.

Legal & Moral	Legal & Immoral
Illegal & Moral	Illegal & Immoral

Legal & Moral	Having a Child.
Legal & Immoral	Owning a slave pre-civil war in the US.
Illegal & Moral	Smoking Marijuana?
Illegal & Immoral	Killing an innocent person.

The Law and Ethics Relationship
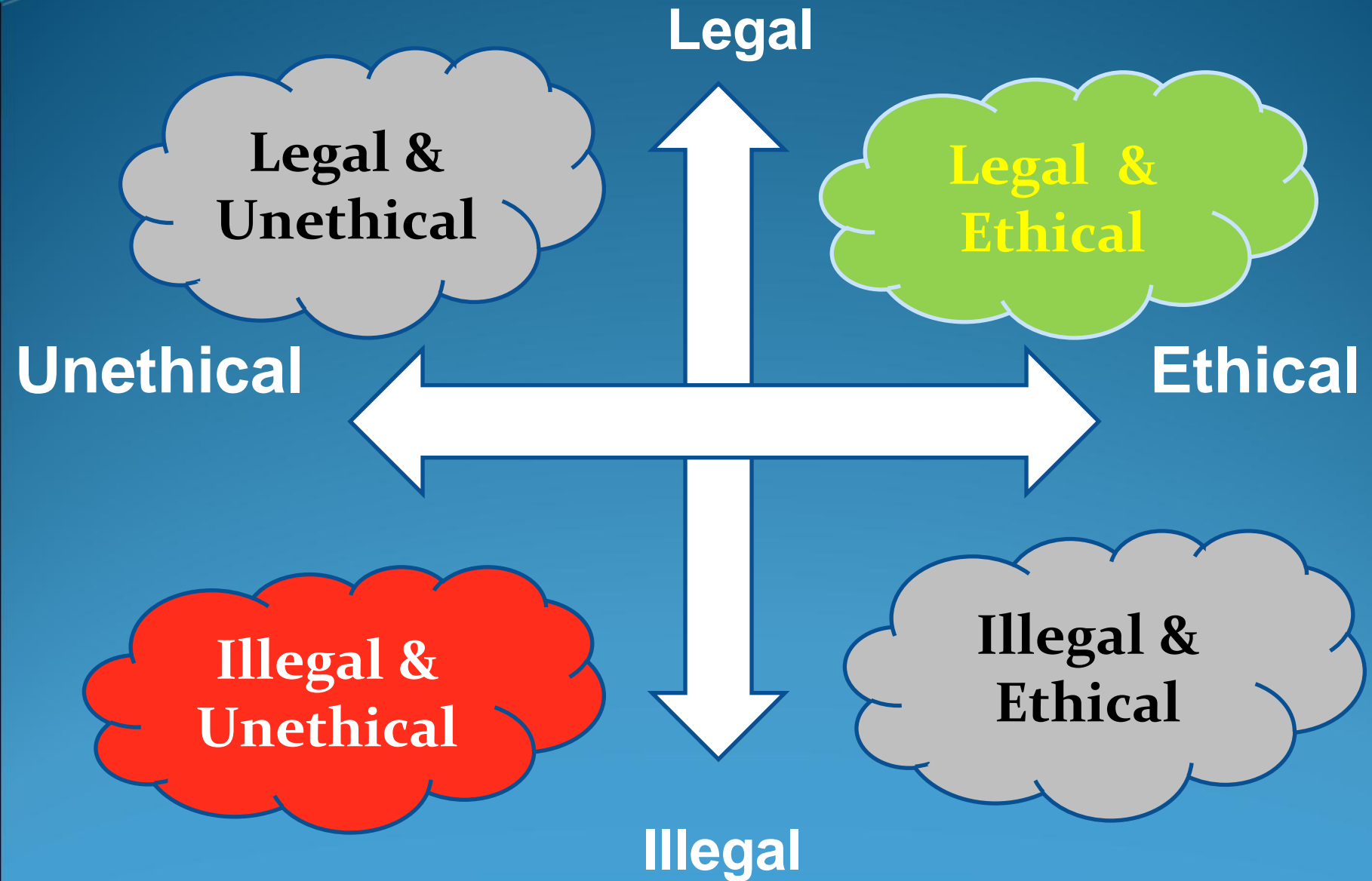
To determine the relevant goals and means to those goals we need to look at concrete cases.

Why does practical reasoning, and so too ethics and law, require studying concrete

CASES?

Why CASES?

Consider again nuclear power. The ends generally remain the same -- in this case health, safety and bio-diversity -- but the means will change as resources, knowledge and technologies change.

Suppose an effective medical treatment is discovered for radioactive poisoning. Such a medical breakthrough would change profoundly the means-goal reasoning regarding nuclear power.

So why CASES?

Cases – and the case method – is elemental to ethics (and law) because the means, and to a lesser extent, the goals, change historically.

Cases call upon the means and goals that are relevant to the present day.

Let's look at a concrete case involving civil engineering

You're an engineer who works for the Santa Cruz County Road Commission

Your job centers on:

maintaining the safety of the roads going through the Los Gatos Mountains.

This case is adapted from Harris, Pritchard, and Rabins. (2005) Case #57, "Trees." In *Engineering Ethics,* 3rd Ed. Belmont, CA: Wadsworth p. 344.

Factors to consider:

A. The traffic on roads and highways through the Los Gatos mountains continues to increase.

B. In the past five years there has been a growing increase in the number of accidents.

(Particularly bad accidents involve motorists crashing into to trees which are close to the pavement)

Factors to consider (cont.):

C. Some of the worst accidents have occurred on a three mile stretch on Highway 9 where a stand of ancient redwoods closely lines the highway.

Factors to consider (cont.):

D. Two law suits have been filed against the "road commission" for not maintaining road safety.

   But both law suits were dismissed because the drivers were well in excess of the 35-mph speed limit.

Given the increase in traffic, the Santa Cruz County Road Commission keeps on pressing you, the engineer, to come up with a plan to make the roads more safe.
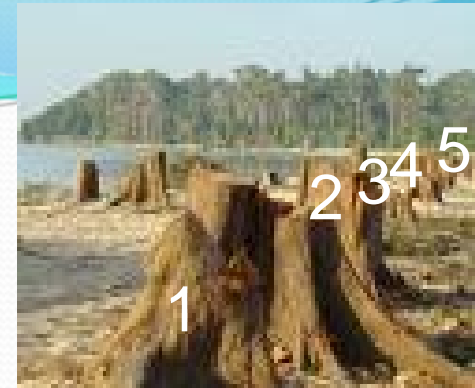
What do you do?

You devise such a plan:
It involves cutting down 5 ancient redwoods that stand dangerously close to the pavement of Highway 9.

2 3 4 5

1

Your plan is accepted by the Santa Cruz County Road Commission.

APPROVED

HOLD IT!

2

No sooner does the plan become public, than angry emails, telephone calls and letters pour in from local citizens concerned about the environment.

Jessica Rodriguez, a spokesperson for a citizens' environmental group, says:

... "These accidents are the faults of careless drivers. Sue the drivers if they don't drive safely."

…"Let's preserve natural beauty and ecological integrity around us while we can."[1]

1. This case is adapted from Harris, Pritchard, and Rabins. (2005) Case #57, "Trees." In *Engineering Ethics,* 3rd Ed. Belmont, CA: Wadsworth p. 344.

What do you do?

You need to practice __ethical reasoning.__

Ethical practical reasoning, recall, is about finding the best – or at least the better -- means to a goal.

But often we find ourselves in a situation when more than one goal applies. It's in such situations that we usually find ourselves in an ethical quandary. So what do we do when goals conflict?

Ref 7

In general, your goals as engineers are spelled out in engineering professional codes, such as - - -


1. The National Society of Professional Engineers (NSPE) Code of ethics**.

2. The Engr. Professional Organizations for all engineering disciplines have their own code of ethics (IEEE, ASCE, ASME, ASQC, etc)

** http://www.nspe.org/Ethics/codeofethics/index.htm

The code spells out your <u>general</u> professional goals. ***But, it can't*** tell you what to do in any particular case, such as the problem with vehicle/tree collisions on Highway 9.

The code, in fact, underlines the **<u>conflict</u>** you're trying to resolve.
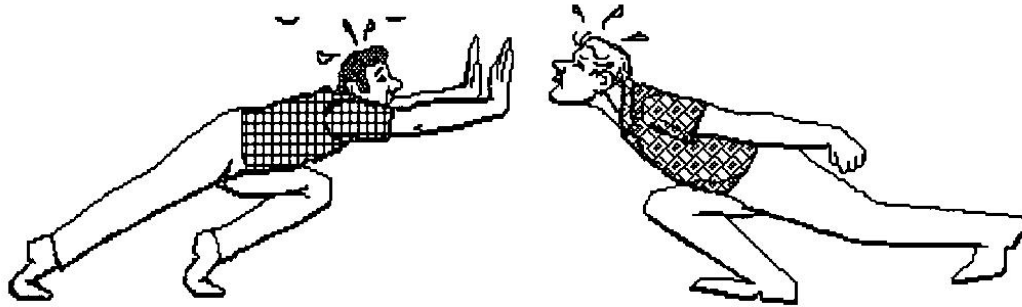
Ref 9

Fundamental principle **#1** of the CE Code, says
you should use your skill and knowledge to enhance
"human welfare and the environment."

--- So, then you should preserve the *trees.*

Ref 10

But fundamental principle **#2** of the CE Code says you
should "honestly and impartially" serve the public,
your employer and clients. ---

---So you should serve the motorists and
widen the road and chop down the *trees.*

Ref 11

How can you apply practical ethical reasoning?

An age-old technique involves making analogies with *paradigm cases* which are understood as ethical and then examining and altering the features until a creative solution is found.

The technique is traditionally known as **analogical reasoning**.

You start with a *paradigm case.*

What is a *paradigm case*, (an **ideal case**), of a good highway for Highway 9?

It would have:

a. minimal obstacles to traffic flow.

b. grading to offset centrifugal force at turns.

c. texture to minimize slippage during rain.

d. postings of clear signage.

e. protection against collisions through medians and guardrails.

Now you think 'analogically.'

Are there any analogies, or similar features, that emerge from some of the features of the ***paradigm case*** that would move towards resolving the conflicting goals?

What about the last feature in the *paradigm case*: *(e) "protection against collisions through medians and guardrails"?*

You think about analogies to guardrails.

What about stone wall guard rails?

If such stone walls were properly <u>contoured</u>, they could both guide the motorists away from colliding with the trees and at the same time leave openings for the living trees.

You have a possible solution to this ethical dilemma.

Maybe you'll need to propose a feasibility study and test the proposal, perhaps through models, but it does satisfy both conflicting goals.

It'll make the three mile stretch on Highway 9 safer from tree collisions and at the same time preserve the rustic character of the redwoods—

                    -- and the trees themselves

Let's go back to the Santa Cruz County road safety case:

You could start with the other side of the ethical dilemma:

"your goal to preserve the environment."

 You consider the stand of ancient redwood trees alongside the three mile stretch of Highway 9.

Again you'd consider a *paradigm case.*

In this instance it would be the *paradigm case (ideal case)* of an ecologically well-managed redwood forest in Santa Cruz County.

The ideal treatment of the forest would likely involve:

No cutting down of the redwoods.

Protecting trees from toxic or contaminant human emissions.

Permitting human access to the forest through trails, and, as the saying goes, enforcing that visitors "take only pictures and leave only footprints."

So, again, you think 'analogically.'

Are there any analogies, or similar features, that emerge from the features of the *paradigm case* that would move towards resolving the conflicting goals?

What about the last feature in the *paradigm case*: "*Permitting human access to the forest through trails, and, as the saying goes, enforcing that visitors 'take only pictures and leave only footprints.'*"

Now think about analogies to the ways people can access the forest.

What if the five trees were removed but done so to

a. create a public facility for visitors to study and learn about the redwood forest and . . .

b. to provide better access to forest trails.

This <u>second solution</u> would clearly be more expensive than the first .

(*and likely would require a ballot measure appearing in Santa Cruz County elections*)

but it would respond to both goals:

1st : <u>the motorists' safety</u>;

2nd : <u>the environmental concerns</u>.

Now let's go over what we have covered so far.

There are certain kinds of problems that are treated by <u>practical reasoning</u>.

For engineers they come up very often and can have very serious consequences.

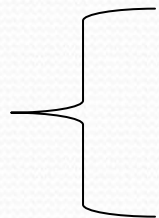There are <u>two</u> main parts to handling <u>ethical problems:</u>

1st . Understanding the conflicting goals that make up the ethical dilemma.

2nd . Considering ***paradigm cases*** that apply to each goal

An example of a very simple personal ethical problem (1st part):
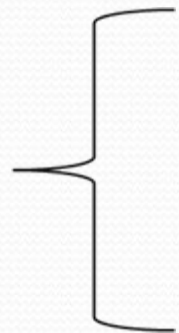
A friend calls you and says s/he is desperate and needs you to "help her/him get through the night." Say, you also have final exam tomorrow. Your performance on the final exam will weigh heavily on your future job prospects.

Let's remember that as in every ethical problem, there's a conflict of goals involved.
In this case they are:

Loyalty to your friend;

Attending to your own self-improvement.

In the Santa Cruz County motorist safety case, the conflict was between:

The goal of ensuring the safety of motorists on highways and roads in Santa Cruz County

The goal of preserving ancient Redwood trees.

The **2ⁿᵈ** main part of ethical problem-solving consists in considering *paradigm cases* that apply to each goal, such as:

the *paradigm case* of the safe road in Highway 9

the *paradigm case* of forest preservation in Santa Cruz County.