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Moral Justification for Environmental Justice

Engineers are a practical lot. We apply the sciences with the intent of changing things for the better. We see a problem or a blank slate and envision something new, something better. At times, this practicality pushes us toward a mode of going with what works and not thinking too deeply about the theoretical underpinnings of what we do on a day-to-day basis. We are reminded to "think outside the box" when confronted with seemingly intractable problems. This is not by accident, but is the result of our academic and professional training.

We have been well prepared for our fields, for some of us beginning long ago, by first grasping the mathematics and physical principles of science. We are often put off by philosophy and its ilk, but these disciplines really can be valuable to us. Most of us do not consider the theory behind physical principles to do our jobs, but we have considered these concepts along the way as part of our academic preparation. By analogy, an understanding of environmental justice must also be steeped in an appreciation, a moral justification, of what we do. The moral principles and canons espoused in our codes of ethics are practical manifestations of deeper moral and philosophical justifications, in much the same way that our designs and calculations are rooted in mathematical and scientific foundations. Thus, it is worthwhile to consider the moral rationale for our daily practice in what makes us not only competent, but also moral, professionals.

Justice requires reason, but is seldom obviously rational. Reason must be informed by practical experience and a set of values. For engineers, these values are to a limited extent codified in our standards of practice (i.e., codes of ethics). But—here is the challenge. Justice cannot be formulaic. We cannot plug in some values, set certain initial and boundary conditions, and expect some proven and general principle to yield a "Navier–Stokes"-like result. If the principles of environmental justice or the fair treatment of all people were universally upheld by everyone at all times, there would be no need to justify it. For example, we do not need to justify that pain is bad. Pain is simply bad, and that's all there is to it.[1] Yes, there are times when pain is necessary, such as may be true for a visit to the dentist, but we put up with it because it is for our long-term benefit. Pain is still something to be avoided if possible.

The fair treatment of all persons is not in that category, however. What exactly is *fairness,* and why ought we to be fair to others? The concept of fairness and justice needs to be clarified and solid arguments advanced if we are to convince others that these

are worthy goals. This matters not only as a large engineering issue, but as a way that the individual engineer conducts business. It is not simply a philosophical or theoretical concept, but is part of the engineer's tool kit. No project is complete unless matters of justice are incorporated. Thus, just as any project must include a good design, a reasonable approach for building and implementing the design, and a means for ensuring that the design criteria have been met, so should that project be designed to be fair and just.

FAIRNESS AND DISTRIBUTIVE JUSTICE

Part of the difficulty in defining justice is that justice and injustice are not often distinguished by the ''what'' so much as the ''how.'' For example, the act of ''taking'' is morally neutral (i.e., neither good nor bad), depending on the conditions of the taking. Taking, in fact, has been in the news recently, as the U.S. Supreme Court ruled in July 2005 that certain private concerns may use eminent domain ostensibly to take private property for the public good. Some would say that this is good, since the private enterprise is improving things (e.g., enhancing the local tax base). This is a utilitarian perspective; that is, the proponents perceive a greater good, with the end (larger tax revenues) achieved by defined means (the taking of private property that yields much lower tax revenues). Others consider such taking to be immoral and a violation of the intent of the U.S. Constitution, since such powers are granted only to public entities, and the *public good* is a strictly defined term. Also, they see the takings as an encroachment or even an outright assault on individual freedoms. At a more basic level, most faith traditions consider ''stealing'' to be an immoral form of taking.

As a moral concept, fairness is a relatively new idea and is thought to be at some higher level than most basic moral rules, such as rules against lying, stealing, and the like. Fairness, the equal application of morality to all people, is a much more sophisticated concept. However, fairness has been built into many value systems throughout recorded history. For example, during the time of the Roman Empire, tax collectors were local citizens in the remote provinces who were required to collect a certain sum from citizens. In addition, they were allowed to collect monies beyond what was due to the empire as personal commissions. Thus, the tax collectors were despised by the local people because they were seen as disloyal and because their methods of collection were deemed unfair.[2] This is one of the first examples of professional ethics, or more correctly, of public dissatisfaction with the ethics of a profession. It is also an example of how justice is defined by the ''how'' *versus* the ''what'' in a matter. Many reasonable persons at the time may not have begrudged the local tax collectors rightful wages. The injustice consists of the inflated amounts taken as well as the extortion and the tactics used in the gain. Fast-forward to contemporary times and there is similar discomfort with unfairness, such as insider trading in the stock market, exorbitant interest rates, price gouging, corporate cheating, excessive corporate salaries, ''big box'' department stores replacing local downtown businesses, political chicanery, and even ''legacy'' college admissions. Fundamentally, these are perceived as unfair practices (the ''big guy'' exploiting the ''little guy'').

The idea of fairness as a moral vehicle for individual and professional ethics, however, was not adequately explored until John Rawls wrote his hugely influential book, *A Theory of Justice* (first published in 1958), in which he proposed that justice is fairness.[3]

For Rawls, justice emerges when there is a fair compromise among members of a true community. If people are fairly situated and have the liberty to move and better their position by their own industry, justice results when they agree on a mutually beneficial arrangement. Fairness is the right ordering of distributed goods or bads, and fair persons are those who, when they control distributive processes, make those processes fair. This is a circular definition, of course, defining fairness as the fair distribution of goods, so let's try another approach.

The concept of distribution is familiar to the engineer. So, for a moment, let us think of justice as a commodity that can and should be distributed fairly throughout society (i.e., distributive justice). Allocating things of value that are limited in supply relative to demand has various dimensions. Justice in this regard depends on what is being allocated, such as wealth and opportunities. For example, in discussions on fair taxation, one often hears arguments concerning the meaning of a "fair redistribution of wealth." Other variables include the diversity of the subjects of distribution: for example, people in general, people of a certain country or national origin, citizenship status, socioeconomic status, or even people *versus* other components of ecosystems. The basis of *how* goods *should* be distributed also varies. For example, some philosophies call for equal distribution to every member of society (known as *strict egalitarianism*), others for the characteristics of people comprising a population (varying by age, handicaps, or historical biases), and still others based purely on market forces (such as *strict libertarianism*).[4]

Whereas the idea of fairness is tied to many ethical principles, such as justice, reciprocity, and impartiality, the word *fair* can have other meanings as well. For example, there is the problem of the *free rider,* a person who uses the contributions of others in society to better his or her position but does not participate in the cost of the society. A person who does not pay taxes for religious reasons still uses the roads and public services, for which others pay. We would deem such actions "unfair" since that person would be taking social goods without contributing to the social welfare.[5]

Another meaning of *fair* is the receipt of good or bad events beyond the control of society. For example, a person whose trailer is destroyed by a tornado while other trailers in the vicinity are spared would call this "unfair," although there is nothing unfair (in moral terms) about a random event of nature. However, if the random occurrence is followed by a willful act, such as increasing the costs of needed supplies following a natural disaster, commonly called *gouging,* such an act *would* be considered unfair. A corollary type of unfairness would be an engineer's decision to provide substandard services to public clients, such as the design of a public housing or school project, simply because the opportunity presents itself.

A popular use of the word *fair* relates to how events beyond the control of society treat the person. For example, a person might get a debilitating disease such as multiple sclerosis, a neurological illness that strikes only young people. Although it is a tragedy for that person and his or her family and friends, contracting multiple sclerosis is not a case of unfairness. It is a sad event, but it is not unfair. On the other hand, if human suffering is caused by premeditated human actions, such as decisions to release toxic pollutants into the environment, thereby increasing the risk of human illness, such decisions *would* constitute unfairness.

Thus, we are looking for a connotation of fairness that distinguishes such unfortunate confluences of events (such as the genetic expression of chronic diseases) from those where human decisions have caused unfairness or have not accounted properly for certain

groups and which have led to adverse consequences. The definition we want to propose is that fairness occurs with the honoring of appropriate and just claims. Another way of saying it is that fairness is a process where the legitimate claims of each person are respected.[6]

The ancient Greeks considered fairness to exist when equals were treated equally and unequals were treated unequally. That is, fairness occurs when identically situated people are treated identically. When there are no significant differences among various people, they all ought to be treated equally.[7]

The problem of course comes in the definition of *significant*. What characteristics are "sufficiently significant" to allow for disparate treatment?[8]

Example:

Significant Difference

Two people, a man and a woman, apply for two identical jobs at a private company. The man is offered a salary of $40,000 and the woman is offered a salary of $30,000. Is this difference in pay morally right or fair. If not, what makes it immoral?

Since the jobs are identical, there has to be a justification for the difference in pay. Since gender is not a significant difference, this appears to be a clear case of discrimination and unfairness.

But let's complicate the example. Suppose that the job was to unload trucks, and the strength and stamina of the worker made a difference in productivity. Would the company be justified in hiring a person who will be physically able to perform the needed task? The company might argue that a man would probably be able to perform the job as required, whereas a woman would not. But this is stereotyping. Perhaps a woman can prove that she is able to perform as well as a man. If in that case her salary is still lower than the salary for the man, this would be a case of unfairness. The problem is that most private companies prejudge the ability of a person to do a job based on stereotypes and would not give a woman the opportunity to show what she can do.

In most cases, gender or race or country of origin is not a "significant" difference that allows disparate treatment; Discrimination on the basis of such difference is patently unfair.

Let us complicate the example even further. What if a job were only offered to males or to women over the age of 50? Is this unfair? If the job entails exposure to dangerous levels of chemicals known to be *teratogens* (those that cause birth defects), is it fair to allow women of child-bearing age to work there? Should *all* women in this group be prohibited?

The equal treatment of equals is also one of the conundrums of *affirmative action.* Does fairness demand retribution for past wrongs committed to an identifiable social group? When is fairness the same as *equity* (equal treatment) such as equal housing and employment opportunites, and when does fairness require a more affirmative approach

to repair past and ongoing injustices (e.g., lingering effects of generations of uneven educational achievements, union membership, and career opportunites due to institutional, intentional, and even sanctioned biases). Equal opportunity seems to imply "equals treated equally," whereas affirmative action calls for some effort to treat "unequals unequally." One way to resolve this might be to define fairness as a lack of envy, when no participant envies the lot of any other. This is not, however, necessarily fair, since the claims of some people might be exaggerated.

Example:	**Fair Distribution**

A farmer is retiring and wants to distribute his farm of 300 acres among his three sons. What is a fair way of distributing the land?

If the sons are equal in all significant (there's that word again!) ways, the farmer would divide his farm into three 100-acre plots. But suppose that one son claims to be a better farmer than the other two and insists that this ought to result in his having a larger share of the 300 acres. A second son might need 120 acres because he wants to sell the land for a new airport, and thus stakes his claim for the larger lot. A third might say that since he has more children than the first two, he needs a larger share because eventually, he will have to subdivide his plot among more offspring.

Are any of these claims significant enough to change the initial distribution of 100 acres each? It would be unlikely that a disinterested arbitration board would respect any of these claims, and thus the different claims should not result in a division different from the 100 : 100 : 100 distribution. Each of the three sons might go away unhappy, but the process has nevertheless resulted in a "fair" division of the goods.

The units used to divide some scarce resource are also important. In the example above, the units are acres of land. But not all land is the same, and some of the 100-acre plots might have water, others trees, and others valuable minerals, and a truly fair distribution would then take all such variables into account. If these can be expressed in a common denominator such as dollars, a fair division is at least theoretically possible. On the other hand, some land might have special meaning or memories, and this value cannot be included in terms of dollars, and since these valuables are probably viewed differently by each son, fair distribution is possible.

The injustices done to Native Americans in moving them from their ancestral lands to reservations were an example of using the wrong units for compensation. The land areas given in compensation were supposedly equal to those taken by the government, but the loss of sacred lands was devastating to nations such as the Cherokees. Even if the land area was equal, this was in no way a just or fair process.

Western culture, especially engineers, like to quantify, but some valuables defy such calculation. This is a common challenge at town meetings and hearings. The facts and figures may be wasted on many in attendance simply because the river, lake, building,

neighborhood, or school is more than its physical dimensions. It has subjective and abstract meaning and value that can easily be missed in an environmental impact assessment or actuarial report.

Another problem with an envy-free approach to fairness is that it depends on each person having a similar personality. Suppose that of the three farmer's sons in the example above, one is not very astute in business, and the other two brothers convince him that he should take only 60 acres, leaving 240 acres to be divided between the other two brothers. The naïve brother does not object and the deal is consummated. It is an envy-free division. But we recognize that such a division is eminently unfair to the less astute brother.

We have to conclude that defining fairness as a lack of envy thus does not seem to be useful; and at its worst, it can be a tool for unfair distributions. After all, there is no shortage of those who live by the maxim "Never give a sucker an even break."[9] Unfortunately, there is no shortage of those who would take advantage of another's ignorance, naiveté, and sense of fair play.

Perhaps we can get some help from other professions in trying to define fairness. One means of determining fairness in the legal profession is the *reasonable person standard.* A fair distribution of goods occurs when an objective outsider, taking into account all the claims of the participants, renders a decision that would be agreed to by most rational, impartial people as being equitable to all, regardless of each individual claim. In common law, the reasonable person standard is a "legal fiction" since there really is not such a person. But this is not necessarily a bad thing because it provides a means to analyze a situation that is evoking strong emotions for and against a decision. By creating a hypothetical person whose view is based solely on reason provides a means of looking at the situation in a less biased way. *Bias* is another of those terms with a distinct engineering meaning, that is, it is a systematic error. Thus, the reasonable person standard helps to recalibrate our sense of fairness in the same way that we calibrate our scientific apparatus against a known (i.e., rational) standard. We would expect an arbitration board to apply such a rational approach to determining fairness.

Another way of describing fairness is to define what we mean by its opposite: unfairness. Rescher[10] identifies three types of claims of unfairness that might be valid:

- Inequity
- Favoritism
- Nonuniformity

Inequity   Giving people goods not in proportion to their claim is an inequity. The opposite would be *equity,* a condition where people's shares are proportional to their just and appropriate claims.

For example, suppose that a business goes broke and creditors are lining up for their share. Say that the business has $100, but three creditors each are owed $50, $100, and $250. An equitable distribution of the available funds would pay each one 25 cents on the dollar, so the three claimants would get $12.50, $25, and $62.50 each. Of course, the claims have to be proven to be just claims.

Favoritism   Some conditions that have nothing to do with the issue at hand (e.g., one's relations or one's religion) ought to have nothing to do with the situation or claim. The opposite would be *impartiality,* the even-handed distribution of goods without favoritism.

In the bankruptcy example above, suppose that the executor decides to pay out $50, $50, and $0 to the three creditors because the first creditor is a local merchant and the last is an international bank, believing that it is more important to support the local merchant than some far-off impersonal bank. This distribution is unfair since the type of business ought not to be germane to the distribution of the available funds.

Nonuniformity   "Equal treatment under the law" means that the law is to be applied to all people regardless of their status or wealth. The opposite is *uniformity,* the uniform application of the rules.

Suppose a dinnertime rule in a family is that all vegetables have to be eaten before dessert is served. Some children will not always kill off the last pea, hoping to get away with the small transgression. If the parents allow this for all of their children save one, the one who is held to the strict rule can rightfully claim to have been treated unfairly. The rule was not evenly applied.

However, returning to the Greek definition, fairness is not equalitarianism: that is, the treatment of all people equally. To function, society occasionally has to impose unequal treatment of some. For example, the military draft was patently inequalitarian. Only some people were to be drafted, others were not. Those drafted may have ended up in harm's way, and certainly would lose time out of their lives. But it is not possible to send partial persons into the army. If the need is for 100,000 soldiers out of an eligible population of 10,000,000, everyone has a 1% chance of being drafted. The key here is that the draft, the process by which the 100,000 will be chosen, has to be fair. Everyone ought to have an equal chance of being drafted unless they are able to show some significant reason why they should be exempt. If you recall the Vietnam era, exemptions such as college deferments and conscientious objection, were the stuff of controversy and moral debates.

One of the principles of our society is that all persons are to be treated equally under the law. But this does not mean unqualifiedly equal. Some identifiable groups of people such as professionals are treated differently under the law. All professional pharmacists, for example, are allowed to dispense drugs, whereas this activity is illegal for the non-professional. All people in the category "pharmacists" are then being treated differently from other people. Unfairness occurs when a pharmacist, because of some irrelevant differences such as gender, religion, or shoe size, is not allowed to dispense drugs. Similarly, although we want to treat all people the same when they have committed a crime, this is seldom done. For the same crime, a first offender might receive a different sentence from that of a repeat offender, and most would agree that that is "fair."

Equality before the state is also important, in that goods distributed by the state (and goods taken by the state) are not equal but are equitable. The progressive income tax requires rich people to pay a larger percentage of earnings than poor people on a per person basis, and welfare recipients need to show that they are destitute before they can receive assistance. The important objective of fairness is that each person be treated equitably within the process. So a rich woman ought not to have to pay more taxes than a rich man, all other things being equal.

Perhaps the best definition of fairness that is useful in our discussions of environmental justice is to say that fairness is treating each person the same according to dem-

ocratically accepted and agreed-on rules, and whenever these rules result in unequal treatment, there has to be a good and acceptable reason for the inequality.[11]

What makes unfair treatment immoral? Such treatment becomes immoral when the claims of individuals are not respected. For example, is it unfair to exclude women from the Rotary Club? The male members might claim that this is a private club and they have a right to exclude whomever they wish. There is, after all, a vote of the membership for admission of new members. But the Rotary Club is not purely a social club because it is made up primarily of business people, who often discuss and transact business during the meetings. To exclude women from such interaction is unfair and immoral. On the other hand, is it fair for a women's golf team to exclude male members? One argument is that since golf is partly dependent on strength and on average men are stronger than women, allowing men to compete on the same level with women would destroy the integrity of the women's golf game, and the exclusion of men is neither unfair nor immoral. Unfairness in this case could result from applying standards that do not help achieve the "actual ends" (e.g., golf playing) but some other hidden end (e.g., men-only golf clubs).

At this writing this is a strongly debated issue for professional golf and its prestigious Masters tournament (which is based at an exclusive golf club in Georgia). Arguably, this points to a more important aspect of fairness: systematic exclusion. For example, it has only been a few decades since job selection criteria included questions about one's intentions to have children, whether one owned an automobile, or whether one can lift 50 pounds. It is, of course, no one's business how a person gets to work (private automobile, bike, public transportation, or a Jetsons' flying car!), and thus an irrelevant question can only result in unfair treatment. A general rule is that if the job that needs to be performed is not affected by the answer given to a question in an interview, such a question should not have been asked in the first place.

A fair division of goods may not be democratically popular. Consider a country with two primary religious sects, one with 40% of the population and the other with 60%. An election is held, and the majority of people (the 60%) decide to prevent any and all goods from going to the minority 40%. This is obviously unfair, even though the result has been arrived at democratically.

The siting of undesirable facilities such as a landfill is just such a problem. If fairness is to be decided by the majority, the wealthier and more powerful members of a community would choose to site a landfill at one location and then hide the decision behind a democratic vote, saying that this is legitimate and fair. Such a selection of a landfill site may have been legitimate and democratic, but it would have been patently unfair if the claims of the people who get the landfill in their backyard have not been respected.

Fairness also has a time component; that is, like other aspects of engineering, justice is constrained in time and space. The example of siting the facility unfairly is a spatial injustice (i.e., where we put the landfill determines the injustice). Sometimes, it is not so much what or where, but when an action takes place that determines its fairness. In the words of the British statesman William E. Gladstone (1809–1898): "Justice delayed is justice denied." Excluding people from key decision points or waiting to involve them until enough momentum for the project has been gathered is a manner of injustice. Not accounting sufficiently for future generations (e.g., nuclear waste dumps, mine subsidence, or future declines in property values) is arguably an unfair practice.

Finally, a different connotation of the word *fair* is to denote that something is neither very good nor very bad. For example, in the old adjective grading systems, a grade of C was often described as fair. This was to let the guardians of the student know that although the student was not failing, he or she was not doing an excellent job in the course. At first blush, this connotation may be seen as very similar to "equal opportunity." Rather, fair in this use is actually a utilitarian or statistical concept. A fair decision from a utilitarian viewpoint is one that provides the greatest amount of benefit for the greatest number of people. So if a benefit-to-cost ratio (B/C) is calculated from different segments of society, the option that provides the best overall B/C value for the largest segment of society would be chosen. Such a perspective is akin to the statistical concept of a normal distribution (see Figure 2.1). In other words, if we assume that the benefits and costs (or risks) in a given situation are normally distributed within a population, we would be able to select the fairest option as the one where most of the population receives, on average, the largest benefits *versus* costs or risks. The normal distribution translates into the very well off *and* the very poor receiving the least benefits and most of the population receiving the lion's share of benefits. This can occur, for example, in economics, where the very poor receive a stipend from the government or low-paying jobs and the very rich are taxed at an increasingly high marginal rate (i.e., a "progressive" tax), but the majority of the population receives the most goods and services from the government. The highest B/C ratios are those near the statistical measures of central tendency: the mean, median, and mode.

The normal distribution analogy appears plausible until some of the other aspects of fairness are considered. In fact, this can be one of the most unfair ways to decide on environmental issues, since it places an undue and disparate burden on a few groups; and
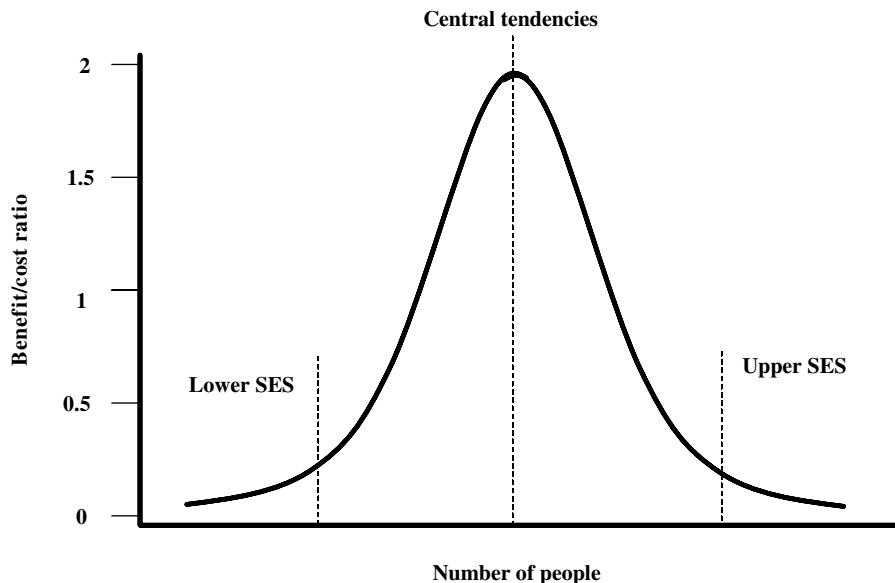

Figure 2.1 Conceptual model for selecting a "fair" option from a utilitarian perspective when the benefits are normally distributed.
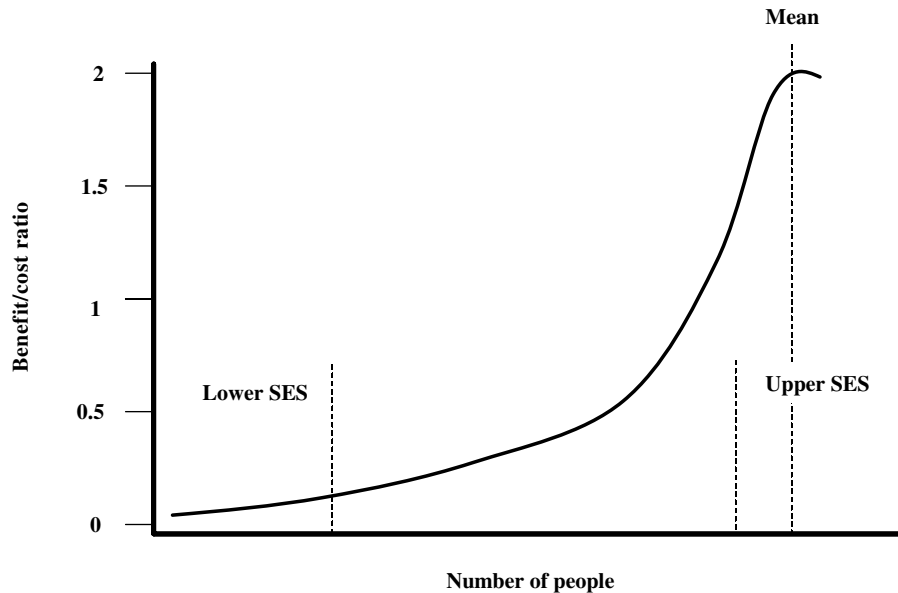
Figure 2.2 Conceptual model for selecting a ''fair'' option from a utilitarian perspective when the benefits are skewed in favor of the higher socioeconomic strata.

these are often the ones least likely to be heard in terms of pointing out costs and risks. This is known as the *tyranny of the majority.*[12] Often, the curve is not normally distributed but is skewed in favor of the higher socioeconomic strata (see Figure 2.2). Sometimes, it is doubly unfair because the people assuming most of the costs and risks are those that receive the fewest benefits from this particular decision.

These curves demonstrate the importance of the concept of ''harm'' in fairness. No group should have to bear an ''unfair'' amount of costs and risks. This is why John Stuart Mill added the *harm principle* to utilitarianism and why John Rawls argues that one must empathize with the weakest members of society. Rawls argues that the only fair way to make a moral decision is to eschew personal knowledge about the situation that can tempt a person to select principles of justice that will allow them an unfair advantage. This is known as the *veil of ignorance,* but it is really a way to implement Mill's harm principle. So fairness also involves more than utility and more than a good B/C ratio; it requires virtue.

Discussion: Harm and the Hippocratic Oath

The Hippocratic Oath for physicians is an example of a precautionary principle when it states: "First do no harm. . . ." The traditional text of Hippocrates of Cos (ca. 460–377 B.C.) is:

> I swear by Apollo the physician, by *Æsculapius, Hygeia,* and *Panacea,* and I take to witness all the gods, all the goddesses, to keep according to my ability and my judgment, the following Oath. To consider dear to me as my parents

him who taught me this art; to live in common with him and if necessary to share my goods with him; to look upon his children as my own brothers, to teach them this art if they so desire without fee or written promise; to impart to my sons and the sons of the master who taught me and the disciples who have enrolled themselves and have agreed to the rules of the profession, but to these alone the precepts and the instruction. I will prescribe regimens for the good of my patients according to my ability and my judgment and never do harm to anyone. To please no one will I prescribe a deadly drug nor give advice which may cause his death. Nor will I give a woman a pessary to procure abortion. But I will preserve the purity of my life and my art. I will not cut for stone, even for patients in whom the disease is manifest; I will leave this operation to be performed by practitioners, specialists in this art. In every house where I come I will enter only for the good of my patients, keeping myself far from all intentional ill-doing and all seduction and especially from the pleasures of love with women or with men, be they free or slaves. All that may come to my knowledge in the exercise of my profession or in daily commerce with men, which ought not to be spread abroad, I will keep secret and will never reveal. If I keep this oath faithfully, may I enjoy my life and practice my art, respected by all men and in all times; but if I swerve from it or violate it, may the reverse be my lot.

Many contemporary physicians continue to take a reworded oath based on the Hippocratic Oath. The oath actually includes a number of precautionary elements instructive to the engineer. The closest parallel is the first engineering canon: "Hold paramount the health, safety, and welfare of the public," another example of a precautionary principle. It is a call to empathize with those who may be affected by our decisions and actions.

Weaknesses in this connotation of fairness can be demonstrated using an ethical analytical tool: a line drawing.[13] Ethicists use a number of tools to analyze cases for ethical content, but since the engineering profession makes much use of graphical tools, line drawing is a popular technique to analyze engineering cases. This technique is most useful when there is little disagreement on what the moral principles are but when there is no consensus about how to apply them. The approach calls for a need to compare several well-understood cases for which there is general agreement about right and wrong and to show the relative location of the case being analyzed. Two of the cases are extreme cases of right and wrong, respectively. That is, the positive paradigm (PP) is very close to being unambiguously moral and the negative paradigm (NP) unambiguously immoral:

	NP	Our Case	PP	
Negative feature 1		×		Positive feature 1
Negative feature 2		×		Positive feature 2
Negative feature 3			×	Positive feature 4
Negative feature n	×			Positive feature n

Next, our case (T) is put on a scale showing the positive paradigm and the negative paradigm, as well as other cases that are generally agreed to be less positive than PP but more positive than NP. This shows the relative position of our case T:

NP   PP
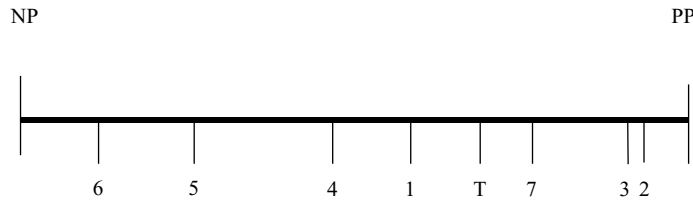
This gives us a sense that our case is more positive than negative, but still short of being unambiguously positive. Does this not imply that if we take this action we are being fair? In fact, two other actual, comparable cases (2 and 3) are much more morally acceptable. This may indicate that we should consider taking an approach similar to these if the decision has not yet been made. Consider the following example, adapted from Fledderman[14]:

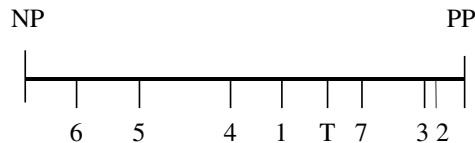**Example:**

Disposal of a Slightly Hazardous Waste

A company is trying to decide how and to what extent it should dispose of a "slightly hazardous" waste. The company's current waste stream contains about 5 parts per million (5 ppm) of contaminant A. The state environmental department allows up to 10 ppm of contaminant A in effluent drained into its sanitary sewers. The company has no reason to suspect that at 5 ppm any health effects would result. In fact, most consumers would not detect the presence of contaminant A until relatively high concentrations (e.g., 100 ppm). The city's wastewater treatment plant discharges to a stream that runs into a lake that is used as a drinking water supply. So is it ethical and fair for the company to dispose of slightly hazardous waste directly into the city sewers?

The positive paradigm in this case is that the company would do what is possible to enhance the health of people using the lake as a drinking water source. The negative paradigm is an action that causes the drinking water to be unhealthy. Here are some hypothetical options the company may have pursued:

1. Company dumps contaminant A at the regulatory limit (10 ppm). No harm, but unusual taste is detected by a few sensitive consumers.

2. The company lowers its concentration of contaminant A so that it is effectively removed by the town's existing drinking water system.

3. Company discharges contaminant A into the sewer at 5 ppm or below, but ensures that it is effectively removed by the town with new equipment bought by the company and donated to the town.

4. Contaminant A can be removed by equipment paid for by taxpayers.

5. Seldom, but occasionally, contaminant A concentrations in water will make people feel sick, but the feeling lasts only an hour.

6. Contaminant A passes through untreated (i.e., 5 ppm), into the steam, where it builds up and causes sensitive people to become acutely ill, but only for a week and with no long-term harm.

7. Equipment is installed at the company that reduces the loading of contaminant A to 1 ppm.

Drawing each case and our proposed case (T) gives us a relative location with respect to the negative and positive paradigms:

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NP                                          PP

|                                            |
|___|____|____|_____|___|____|___|__||____|
    6    5    4    1   T    7    3 2
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Cases 2 and 3 are clearly the most ethical, since the amount of contaminant A that reaches the public is kept well below the regulatory limit and any health threshold. Case 7 is also close to the positive paradigm, since it is well below the regulatory limit, but even at these levels some sensitive people (e.g., newborn, the immunocompromised, the elderly) could experience effects. Cases 5 and 6 are less ethical because they resemble the negative paradigm (i.e., actions that make the water less safe to drink). The key, though, is that in the middle of the diagram (case 4), the burden of the problem caused by the company is shifted from the private company to the public. This is not the fairest option by any means.

Although being right of center means that this case is closer to the most moral than to the most immoral approach, other factors must be considered, such as feasibility and public acceptance. The location on the line indicates that being fair is different from receiving a grade of C. Fairness implies that we need to search for options that move us closer to the positive paradigm (i.e., the ideal). As we migrate toward options in the negative direction, we give up a modicum of fairness. This is the nature of balancing benefits and costs, but the engineer must be fully aware that these balances are taking place. So, like risk assessment, professional judgment in selecting the fairest designs and projects must account for trade-offs (e.g., cost-effectiveness *versus* fairness, security *versus* liberty, and short-term needs versus long-term effects).

Care should always be taken when trying to apply objective and quantitative tools to concepts such as ethics and justice. Social sciences and philosophical principles are often highly subjective. Although the natural sciences and engineering strive for objectivity, they, too, must deal with subjectivity from time to time.

Discussion: Physical Science Is Not without Subjectivity[15]

Engineers and physical scientists can become frustrated with the social sciences and their uncertainties that result from the inherent difficulty of controlling variables when studying human populations. These uncertainties are

manifested in larger errors and greater variability of conditions than those associated with the physical sciences. However, this should not lead one to conclude that there is no subjectivity in the physical sciences. Consider fluid dynamics and, more specifically, viscosity. A recent study[16] has shown marked variability in the applications of one of the basic concepts of fluids: the critical Reynolds number (R_c), which describes whether a flow is laminar, turbulent, or in a transitional state. R_c is defined differently for flow within a circular pipe and flow in an open channel, so the number changes for different systems. Engineering textbooks vary in the way that R_c is defined, leading to various and inconsistent interpretations of whether flow is turbulent or laminar, which is a very important distinction in fluid mechanics.

Some of the subjectivity is the result of the steady march of inquiry and the iterative nature of science. As we learn more, key scientific concepts are refined. Some are even abandoned, but their remnants remain in the lay literature (e.g., watching the sun "rise") or even in scientific circles (e.g., "nature abhors a vacuum"). Frequently, the changes are subtle. The value of R_c was brought home again during a recent seminar held by a Duke engineering graduate student regarding research being directed by Zbigniew Kabala. They were considering how, at a small or micro scale, the geometry of a conduit can have profound effects on whether flow is laminar or turbulent. In fact, engineers generally expect a flow between laminar and turbulent conditions (i.e., the critical flow region to have Reynolds numbers greater than 2000 and less than 4000). Critical flow may also be defined as a flow with velocity = 0 at the walls and twice the average velocity at the center of the conduit (laminar) and a flow with no relationship to the proximity of the wall, due to mixing (turbulent). The student pointed out that at very low Reynolds numbers, in small conduits, flows behaved more turbulently than would be expected in larger systems. In fact, the visual demonstration of the flow using dye showed that the size, and especially the shape, of the pockets lateral to the flow changed the critical range substantially, even to the point where a finite amount of the fluid remained in the pockets (adhering to the walls) well after the remainder of the flow had moved downstream. In other words, when clear water was sent through the conduit, some of the blue dye remained out of the streamlines. Is this why, even though at the meso or macro scale, soil or other unconsolidated material may still contain measurable concentrations of contaminants, even if they have relatively high aqueous solubility? Sometimes, subjective judgment beyond the number is needed to describe a system: in this case, whether R_c represents a turbulent, laminar, or critical system,

This discussion points to the fact that a certain amount of subjectivity can present itself in all sciences, and we must take care not to be condescending to our colleagues in the social sciences and the humanities. Two books by Sheldon Rampton and John Stauber provide ample cases of how the public has been manipulated by experts: S. Rampton and J. Stauber, *Trust Us, We're Experts: How Industry Manipulates Science and Gambles with Your Future,* Penguin Putnam, New York, 2001; and S. Rampton and J. Stauber, *Toxic Sludge Is Good for You,* Common Courage Press, Monroe, ME, 1995.

These books may be better classified as muckraking than as scholastic endeavors, but they do point out some of the ways that *spin* is used to justify decisions. As such, the books provide cautionary tales to engineers on how they may, unwittingly, be parties to deception. The lesson for environmental justice is that the perception of uncertainty can be amplified when engineers communicate with diverse audiences. We may well know that the physical principles hold and that we are applying them appropriately in a particular project, but certain segments of society may perceive that we are not being completely honest with them. This is further exacerbated in neighborhoods that have traditionally been excluded from decision making or with whom the track record of "experts" has been tainted with prevarications and unjustifiable "bills of clean health."

At the risk of stating the obvious, good risk communication is *not* an invitation to compromise the quality of science or to introduce pseudoscientific methods or junk science to keep everyone happy. To the contrary, it is a reminder that we must be just as open and honest about what we do not know as we are about what we know. On more than a few occasions, we have witnessed engineers who believe in a project so strongly that they become advocates to the point that they begin to compromise the actual scientific rationale for the project.

Some of this is the result of *sunken costs,* costs that are so committed and so far down the road that rethinking a project's design and approach is not a workable option. Another factor is the "us and them" problem, wherein the engineer begins to see those who complain, less as clients and more as obstacles that must be overcome. Whatever the reasons, an unwillingness to examine and reexamine a project in terms of its scientific credibility is dangerous.

It does not have to be a fellow engineer who points out scientific weaknesses. For example, some years back, Vallero addressed a group of elementary students in a small town in Missouri. After a brief overview of pollution, including a discussion of the depletion of the ozone layer, Vallero took questions from the students. One precocious student asked a fairly straightforward question: If we have too much ozone down here [in the troposphere] and we are losing it up there [in the stratosphere], why don't we just build a system to move the ozone from here to there? Vallero's first reaction was to "school" the student in the ways of science, especially that it was the activities that were causing the two problems and that they were very different from each other. However, the kids weren't buying it, making Vallero's arguments increasing defensive. At some point, he stopped himself and realized that he really wasn't listening and that he hadn't in fact considered the student's idea. After a very pregnant pause, he admitted as much and said he would need to think about it further. Indeed, Vallero has thought about it often since. The "system" may not be what the fourth grader had in mind (e.g., tubes stretching into the sky), but since the atmosphere is a system, stratospheric–tropospheric exchanges must be considered. If they are part of the problem, they may well be part of the solution. The student is probably out in the real world now. We can only

hope that he has become an engineer and may be able to put his thoughts into action!

VIRTUE AND EMPATHY

We argue that being fair and advancing the cause of justice is morally admirable. People who devote their lives to doing the right thing are said to behave *virtuously.*

If one reads the classical works of Aristotle, Aquinas, Kant, et al., the case is made for life being a mix of virtues and vices available to humans. *Virtue* can be defined as the power to do good or a habit of doing good. In fact, one of Aristotle's most memorable lines is that "excellence is habit." So if we do good, we are more likely, according to Aristotle, to keep doing good. Conversely, vice is the power and habit of doing evil. The subjectivity or relational nature of good and evil, however, leads to some discomfort in scientific circles, where we place great import on certainty and consistency of definition. Aristotle tried to clarify the dichotomy of good and evil by devising lists of virtues and vices, which amount to a taxonomy of good and evil. One of the many achievements of Aristotle was his keen insight as to the similarities of various types of living things. He categorized organisms into two kingdoms, plants and animals. Others no doubt made such observations, but Aristotle documented them. He formalized and systematized this

Biographical Sketch: Pietro Angelo Secchi
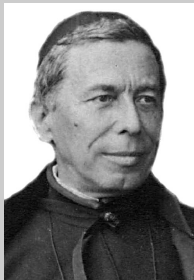
In 1865, the Pope decided that he wanted to test the quality of the water in the Mediterranean Sea and sent the commander of the papal navy to investigate. Pietro Angelo Secchi (1818–1878), the Vatican astronomer at that time, was asked to come up with a way to accomplish the task of measuring water quality. Secchi devised a white iron disk that is lowered over the side of a boat and the depth at which the disk is no longer visible is noted. The deeper the depth, the better the light penetration, and the clearer the water. On April 20, 1865, what became known as the *Secchi disk* was first lowered over the side of the papal steam yacht *l'Immaculata Conczione*. The idea was so simple and worked so well that the Secchi disk was soon adopted by water quality scientists all over the world.

Pietro Secchi was almost famous for another reason as well. He was the first person to use photography to study solar bodies, and his pictures of Mars revealed lines that might have looked like canals. He did not suggest that these were artificial canals, but the imagination of science fiction writers took over and the myth of canals and civilization on Mars was born. Fascination with the possibility of life on Mars continues to this day.

taxonomy. Such a taxonomic perspective also found its way into Aristotle's moral philosophy.

We will not all agree on which of the virtues and vices are best or even whether something (e.g., loyalty) is a virtue or a vice, but one concept does seem to come to the fore in most major religions and moral philosophies: *empathy.* Putting oneself in another's situation is a good metric for virtuous acts. The Golden Rule is at the heart of Immanuel Kant's *categorical imperative.* With apologies to Kant, here is a simplified way to describe the categorical imperative: When deciding whether to act in a certain way, ask if your action (or inaction) will make for a better world if all others in your situation acted in the same way. This is an argument in several environmental areas, including recycling, midnight dumping, sustainable development, and selecting low-toxicity source materials in manufacturing. An individual action's virtue or vice is seen in a comprehensive manner. It is not whether one should pour a few milligrams of a toxic substance down the drain—it is whether everyone with this amount of toxic substance should do so. The overall stewardship of the environment may cause one to rethink an action (as has been the case for decades now). A corollary to this concept is what our colleague Elizabeth Kiss of Duke's Kenan Center for Ethics calls the ''six o'clock news'' imperative. That is, when deciding whether or not an action is ethical, consider how your friends and family would feel if they heard about all of its details on tonight's TV news. That may cause one to consider more fully the possible externalities and consequences of one's decision!

The concept of empathy is central to environmental justice. Justice is the virtue that enables us to give others what is due them as our fellow human beings. This means that we must not only avoid hurting others by our actions but that we ought to safeguard the rights of others in what we do and what we leave undone.

The categorical imperative is emblematic of empathy. Kant uses this maxim to underpin duty ethics (called *deontology*) with empathetic scrutiny. However, empathy is not the exclusive domain of duty ethics. In teleological ethics, empathy is one of the palliative approaches to dealing with the problem of ''ends justifying the means.'' Other philosophers also incorporated the empathic viewpoint into their frameworks. In fact, Mill's utilitarianism's axiom of ''greatest good for the greatest number of people'' is moderated by his *harm principle,* which, at its heart, is empathetic. That is, even though an act can be good for the majority, it may still be unethical if it causes undue harm to even one person. Empathy also comes into play in contractarianism, as articulated by Thomas Hobbes as social contract theory. For example, Rawls has moderated the social contract with the veil of ignorance as a way to consider the perspective of the weakest—one might say most disenfranchised—members of society. Finally, the rationalist frameworks incorporate empathy into all ethical decisions when they ask the guiding question: What is going on here? In other words, what benefit or harm, based on reason, can I expect from actions brought about by the decision I am about to make? One calculus of this harm or benefit is to be empathetic to all others, particularly the weakest members of society, those with little or no ''voice.''

The word *empathy* has an interesting beginning. It comes from the German word *einfühlung,* which means the ability to project oneself into a work of art, such as a painting. Psychologists at the beginning of the twentieth century searched for a word that meant the projection of oneself into another person, and chose the German word, trans-

lated into English as *empathy*. The concept itself was known, such as the Native Americans' admonition to walk in another's moccasins, but it needed a construction. The early meaning of empathy was thus the ability to project oneself into another person, to imitate the emotions of that person by physical actions. For example, watching someone prick a finger would result in a visible winching on the part of the observer because the observer would know how this feels. Some observers actually feel the pain, similar to the pain of the person having the finger pricked, although often not as intensely.

From that notion of empathy it was natural to move to more cognitive role-taking, imagining the other person's thoughts and motives. From here, empathy began to be thought of as the response that a person has for another's situation. Psychologists and educators, especially Jean Piaget,[17] began to believe that empathy develops throughout childhood, beginning with the child's first notion of others who might be suffering personal stress. The child's growing cognitive sense eventually allows him or her to experience the stress in others. Because people are social animals, this understanding of the stress in others, according to the psychologists, eventually leads to true compassion for others.

A problem with this notion of empathy development is that some experiments have shown that the state of mind of a person is very important to that person's ability to empathize. Small gifts or compliments apparently significantly increase the likelihood that a person will show empathy toward third parties. A person in a good mood tends to be more understanding of others. If this is true, empathy is (at least partly) independent of the object of the empathy, and empathy becomes a characteristic of the person.[18]

The psychologist Charles Morris defines empathy as[19] "the arousal of an emotion in an observer that is a vicarious response to the other person's situation. . . .Empathy depends not only on one's ability to identify someone else's emotions but also on one's capacity to put oneself in the other person' place and to experience an appropriate emotional response. Just as sensitivity to non-verbal cues increases with age, so does empathy: The cognitive and perceptual abilities required for empathy develop as a child matures."

Such a definition of empathy seems to be widely accepted in the moral psychology field. But there are serious problems with this definition. First, we have no way of knowing if the emotion triggered in the observer is an accurate representation of the stress in the subject. We presume that a pinprick would be felt in a similar way because we have had this done to us and we know what if feels like. But what about the stress caused by a broken promise? How can an observer know that he or she is on the same wavelength as the subject when the stress is emotional?[20]

If a subject says that she is sad, the observer would know what it is like to be sad, and would share in the sadness. That is, the observer would empathize with the subject's sadness and be able to tell the subject what is being felt. But is the observer really feeling what the subject is feeling? There is no way to define or measure "sadness," and thus there is no way to prove that the observer is actually feeling the same sadness that the subject is feeling.[21] An existentialist might say that this is true for everything, even physical realities, but that is beyond the scope of this discussion.

The second problem relates to nonhuman animals. Psychologists have studied empathy exclusively as a human–human interaction, yet many nonhuman animals can ex-

hibit empathy. Witness the actions of a dog when its master is sick. You can read the caring and sympathy and hopefulness in the dog's eyes.[22]

Humans also have strong emotional feelings toward nonhuman animals. The easiest to understand in these terms is the empathy we feel when animals are in pain. We do not know for sure that they are in pain, of course, since they cannot tell us, but they act in ways similar to the way that humans behave when they are in pain, and there is every reason to believe that they feel pain in the same way. Anatomical studies on animals confirm that many of their nervous systems do not differ substantially from those of humans, and thus there is every indication that they feel pain.

More problematical are the lower animals and plants. There is some evidence that trees respond physiologically when they are damaged, but this is far from certain. The response may not be pain at all but some other biochemical messaging or sensation (if we can even suggest that trees have sensations). Yet many of us are loathe to cut down a tree, believing that the tree ought to be respected for what it is, a center of life. This idea was best articulated by Albert Schweitzer in his discussions on the ''reverence for life,'' the idea that all life is sacred.

Empathy toward the nonhuman world cannot be based solely on sentience. Something else is going on. When a person does not want to cut down a tree because of caring for the tree, this is certainly some form of empathy, but it does not come close to the definitions used by the psychologists.

The third problem with this definition of empathy is that there is a huge disconnect between *empathy* and *sympathy*. If an observer watches a subject getting a finger pricked, the observer may know exactly what it feels like, having had a similar experience in the past. So there is great empathy. But there might be little sympathy for the subject. The observer might actually be glad that the subject is being hurt, or it might be funny to the observer to watch the subject suffer.

Years ago on the popular television show *Saturday Night Live* there was an occasional bit where a clay figure, Mr. Bill, suffered all manner of horrible disasters and ended up being cut, mangled, crumbled, and squashed. Watching this may have elicited some empathy on the part of the observers, but there certainly was no sympathy for the destruction of the little clay man. Its destruction was meant to be funny.

We could argue that a lack of sympathy might indicate that there must also be a lack of empathy. How is it possible for someone to empathize with another person getting a finger pricked but think it to be humorous? Perhaps there has been no empathy there at all. Or perhaps we have conditioned ourselves to laugh at others when they get hurt as a defense mechanisms (e.g., ''whistling in the dark'') to somehow separate the violence from our own experience. Or, we have learned from and have become desensitized by video games to destroy others without regret.

ENGINEERING AND FAIRNESS

Empathy is not a moral value in the same way that loyalty, truthfulness, or honesty are moral values. We can each choose to tell the truth or to lie in any particular circumstance, and a moral person will tell the truth (unless there is an overwhelming reason not to,

Biographical Sketch: Albert Schweitzer
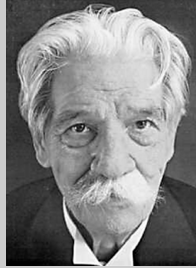
Albert Schweitzer (1875–1965) was born in Alsace, and following in the footsteps of his father and grandfather, entered into theological studies in 1893 at the University of Strasbourg, where he obtained a doctorate in philosophy in 1899 writing a dissertation on religious philosophy. He began preaching at St. Nicholas Church in Strasbourg in 1899 and served in various high-ranking administrative posts. In 1906 he published *The Quest of the Historical Jesus,* a book on which rests much of his fame as a theological scholar.

Schweitzer had a parallel career as an organist. He had begun his studies in music at an early age and performed in his father's church when he was 9 years old. He eventually became an internationally known interpreter of the organ works of Johann Sebastian Bach. From his professional engagements he earned funds for his education, particularly his later medical schooling.

He decided to embark on a third career, as a physician, and to go to Africa as a medical missionary. After obtaining his M.D. at Strasbourg in 1913, he founded his hospital at Lambaréné in French Equatorial Africa. In 1917, however, the war intervened and he and his wife spent 1917 in a French internment camp as prisoners of war. Returning to Europe after the war, Schweitzer spent the next six years preaching in his old church, and giving lectures and concerts to raise money for the hospital.

Schweitzer returned to Lambaréné in 1924 and except for relatively short periods of time, spent the remainder of his life there. With the funds earned from his own royalties and personal appearance fees and with those donated from all parts of the world, he expanded the hospital to 70 buildings, which by the early 1960s could take care of over 500 patients in residence at one time.

On one of his trips up the Congo to his hospital, Schweitzer saw a group of hippopotamuses along the shore and had a sudden inspiration for a new philosophical concept that he called *reverence for life,* which has had wide influence in Western environmental thought. His idea was that all life is sacred and that we should hold it in awe and reverence. Schweitzer would not harm any animal, and at night in the jungle would not have a candle for fear that a moth would fly into it. He agreed that we needed to eat to survive, but he argued that this should be at the lowest level of harm as possible, including not eating any meat.

Schweitzer's contribution is not so much that he established a set of rules for others to follow, but that he articulated by word and example a new way of living—of having respect for the least of nature's creatures.

He was awarded the Nobel Peace Prize in 1953.

such as to save a life). But it is not possible to choose to have or not to have empathy. One either has empathy or one does not. One either cares for those in need, or one does not.

Because we believe that empathy is worthwhile, and respect and admire people who have empathy, we tend to assign moral worth to this characteristic and we believe that people with empathy are virtuous. On the other hand, we do not condemn those who do not have empathy. For example, people who contribute to various relief organizations such as CARE and Oxfam do so because they have empathy for those in need, but many people choose not to contribute. They lack empathy for others in need in this instance, but this does not make them bad people. They simply choose not to contribute.

Can engineers not have empathy and still do good engineering? That is to say, is empathy necessary for good engineering? Certainly on a personal level, engineers are human and they read the same newspapers and watch the same TV news as everyone else, and thus their lack of empathy ought not to be any more or less criticized than the lack of empathy by anyone else. But the truth is that the responsibility of professional engineers is supererogatory to everyday ethics. Engineering ethics is a different layer on top of everyday common morality, and engineers share many responsibilities not required of nonengineers. By virtue of their training and skills, engineers serve others and have certain responsibilities that relate to their place in society. The oft-quoted first canon in many codes of engineering ethics,

> The engineer shall hold paramount the health, safety, and welfare of the public.

is very clear. It states that the engineer has responsibility to the *public,* not to a segment of the public that he or she likes or gets along with, or the segment that employs the engineer, or the segment that has power and money. The engineer is responsible to the public. Full stop. And in doing so, the engineer must help that segment of the public least able to look out for themselves. There is a *noblesse oblige* in engineering, the responsibility of the ''nobles'' to care for the less fortunate.

Thus, to be an effective and ''good'' engineer requires that we be able to put ourselves in the place of those who have given us their trust. The implications for environmental justice are that it has been much easier to export ''canned'' answers and solutions to problems from our vested viewpoints. This view must span time and space. What will the community look like in 10 years if the project is implemented? What happens if some of the optimistic assumptions are not realized? The neighbors will be left with the consequences. It is much better, but much more difficult, to see the problem from the perspective of those with the least power to change things. We are empowered as professionals to be agents of change. So, as agents of change and environmental justice, engineers must strive to hold paramount the health, safety, and welfare of all of the public, we must be competent and we must be fair.

REFERENCES AND NOTES

1. All right, we can hear the physiologists and clinical psychologists, as well as more than a few theologians, vigorously protesting such statements. Indeed, pain is an inherent defense mech-

anism. Without it, animals would repeat many harmful behaviors. The point here is that the response itself is not pleasant, and if given the choice, most of us would choose not to have pain. Granted, the psychopathologists may also be stirred by this contention, noting the masochists, who allegedly enjoy pain. This is probably a learned activity, overcoming the innate avoidance response. It does indicate that even the seemingly universal assumptions have their exceptions.

2. One early example of distributive justice is the advice of John the Baptist to the tax collectors and soldiers who asked how to follow the precepts he had laid out. Luke 3:10–14 states:

> "What should we do then?" the crowd asked.
> John answered, "The man with two tunics should share with him who has none, and the one who has food should do the same." Tax collectors also came to be baptized.
> "Teacher," they asked, "what should we do?"
> "Don't collect any more than you are required to," he told them.
> Then some soldiers asked him, "And what should we do?"
> He replied, "Don't extort money and don't accuse people falsely—be content with your pay."

3. J. Rawls, *A Theory of Justice* (1971), Belknap Press Reprint, Cambridge, MA, 1999.

4. Interestingly, John Rawls (mentioned earlier) is considered to be a contractarian, as are the libertarians, since both subscribe to a form of social contract theory as posited by Thomas Hobbes. Rawls modulated strict contractarianism by adding the veil of ignorance as a protection for weaker members of society.

5. The concept of the free rider shows up in economics on some supply–demand curves. In fact, in a pure supply–demand relationship, the free rider would not exist. That is, since the supply of all goods and services is provided according to their demand (more demand, the greater the cost), no person would receive any goods or services without payment.

6. N. Rescher, *Fairness: Theory and Practice of Distributive Justice,* Transaction Publishers, New Brunswick, CT, 2002.

7. The concept of treating equals equally and unequals unequally shows up in theological and religious discourses. For example, the late Harry Werner, a Jesuit missionary who lived among Native Americans on reservations, noted that the concepts of borrowing and lending are empathic. For example, Werner noted persons who asked to borrow $10 but never returned the money. Werner observed this behavior regularly and was informed by the locals that it makes little sense for someone who has little money to return it to those who have much. Werner had a car and lived in a decent abode, so until the people had such stations in life, there was no moral obligation to repay the money.

   Another instance of treating unequals unequally is the concept of usury. This is mentioned in the Bible, for example, but draws seemingly little attention in Western society. While the contemporary definition is more akin to that of *gouging,* the term *usury* originally meant the charge of *any* interest on a loan. The practice is prohibited in Islam. In the strictest sense, Jews are prohibited from charging interest on loans to other Jews. St. Thomas Aquinas considered the act of charging interest to be immoral since it charges doubly [i.e., both the item (money) borrowed and the use of the thing]. The lender charges for the loan by insisting that the loan be repaid. Thus, the repayment is the charge for the loan. Any further charge is a charge for using the loan. To Aquinas, charging interest on a loan is likened to selling a person a bottle of wine and adding another charge if the person actually drinks the wine! Of course, this is moral reasoning and not business acumen. That is, lending can be a moral good, but this goodness is diminished if interest is required.

8. The term *significant* also has a statistical meaning, related to the probability that an observed result is due to chance alone. An experimental finding is statistically significant if there is a probability of less than some percentage (e.g., 1%) that the difference observed would occur by chance alone (a *p*-value of less than 0.01). Significance is an expression of the probability of a hypothesis being true, given the data. But how does this help us get a handle on fairness?

Often, since engineering involves numerous elements of uncertainty, engineers are willing to accept significance levels much less restrictive that those of our colleagues in the basic sciences. Physicists, for instance, may require a p-value several orders of magnitude more restrictive (e.g., $p < 0.000001$). In this instance the physicist will not accept a hypothesis if there is more than a 1 in a million probability that the outcome is due to chance. On the other hand, our colleagues in the social sciences and medicine, who deal with people with all their uncertainties, may be quite happy to accept a 95% confidence (or $p < 0.05$). If nothing else, this shows that people are difficult to predict and to study.

9. This is the title of a 1941 film by the comedian W. C. Fields. It is similar to the sentiments in the phrase ''there's a sucker born every minute.'' This phrase, which in its simplest connotation means that people are easy to manipulate, has been erroneously attributed to the circus entrepreneur P. T. Barnum. In fact, the quote was made by a competitor of his, David Hannum. In the late 1860s, Hannum and Barnum were both bidding on what they thought was a petrified giant that had been ''found'' (it was actually planted by a hoaxer). When Barnum allegedly had his own giant made, Hannum was quoted as lamenting that these people were being fooled, not knowing that he was the original brunt of the hoax. This account was shared by R. J. Brown online at http://www.historybuff.com/library/refbarnum.html, accessed July 13, 2005.

10. Rescher, note 6.

11. There is, of course, the problem of the majority in a democracy choosing to act immorally. Racial discrimination in the South was for years supported by the majority, but this did not make it morally right or fair to African Americans. We have to assume in this definition that the decisions of fairness are based on defensible moral principles by the popular majority.

12. The phrase was coined by Alexis de Tocqueville and considered at some length by John Stuart Mills. In a democracy, the majority is very powerful. It can influence and even control an entire population, as was done in Germany, where elected officials, including Hitler, gained and abused power. This was much on the mind of the framers of the U.S. Constitution: that the duly elected do not become the tyrants and that those with little power not be crushed. That is why the U.S. is fundamentally a representative democracy and *not* a pure democracy.

13. C. B. Fleddermann, *Engineering Ethics,* Prentice Hall, Upper Saddle River, NJ, 1999.

14. Fleddermann, note 13.

15. S. A. Lowe, Omission of Critical Reynolds Number for Open Channel Flow in Many Textbooks, *Journal of Professional Issues in Engineering Education and Practice,* 129:58–59, 2003.

16. Lowe, note 15.

17. J. Piaget, *The Moral Judgment of the Child,* Free Press, New York, 1965.

18. S. Vaknin, *Malignant Self Love: Narcissism Revisited,* Lidija Rangelovska Narcissus Publications, Shopje, Macedonia, 2005.

19. C. G. Morris, *Psychology: An Introduction,* 9th ed., Prentice Hall, Upper Saddle River, NJ, 1996.

20. This is one of the problems with B. F. Skinner's brand of behaviorism, as articulated in *Beyond Freedom and Dignity* (Hackett Publishing, Indianapolis, IN, 1971). Certainly, we act out on what we have learned, and learning is an aggregate of our responses to stimuli. However, human emotions and empathy are much more than this. Empathy is a very high form of social and personal development. So although one might be able to ''train'' an ant or a bee to respond to light stimuli, or a pigeon to ''play Ping-Pong'' (as Skinner did), even these lower animals have overriding social complexities. At the heart of humanity are freedom and dignity, despite what some behaviorists tell us.

21. Vaknin, note 18.

22. The concept may be innate and extended to other animals, such as elephants' sensing ''awe'' for their ancestral graveyards.