Chapter 6

Engineering

Ethics, *Ethos*, and the Professions: Some Lessons from Engineering

Whistleblowing: Professionalism and Personal Life

Can Engineers Hold Public Interests Paramount?

Trade Secrets and Patents in Engineering: Ethical Issues Concerning Professional Information

Optimization, Option Disclosure, and Problem Redefinition: Derivative Moral Obligations of Engineers and the Case of the Composite-Material Bicycle

The profession of engineering presents a variety of ethical issues, some of which are related to readings from the previous chapter. After all, engineering is a business, or (depending on one's definitions) is at least like a business, since engineering firms strive to attract customers and generate profits. Because many of the ethical problems in engineering pertain to safety issues, the obligations may perhaps be more stringent in this context than in more standard business contexts. Designing cars, airplanes, bridges, weapons, and other items entails risk on the part of users, namely a risk of physical injury or even death. When the stakes are that high, it seems that the engineers designing, constructing, and selling the products take on obligations that are correspondingly more rigorous. However, explaining precisely what those obligations are and determining how they compare to others duties is not so easy. The field of engineering ethics provides ways of addressing these matters.

Managers of engineering firms (who themselves typically have engineering experience) have a variety of different responsibilities. Making sure products are safe is certainly one such responsibility, but so is making a reasonable profit. Thus, there are times when concerns about revenue and public relations may be more important than safety. Should a company spend an extra $5,000 per car to make it safer? An extra $10? What if the net increase in safety is extremely small? Companies could make cars so safe that they are essentially little tanks out there on the road, but then each one might cost $200,000. What counts as "safe enough"? How does one determine where to draw the line? The articles in this chapter are intended to provide ways of addressing these and other questions, whether one is a manager, a "line" engineer (one with no managerial duties), or in any way affiliated with the profession.

In the first selection, Gene Moriarty points out that many engineers do not, as a matter of fact, utilize ethical theory when making decisions with ethical ramifications. Instead, they tend to approach issues intuitively, which means that sound ethical decisions will be made when the engineers have a strong ethos, or good moral character. Since character is emphasized by virtue ethics, it makes sense to point out some virtues that are important in this profession; if engineers can have an understanding of the main engineering virtues, then sound ethical decisions are more likely to be made, even if the details of virtue ethics as such are not grasped. Because the various considerations that arise in engineering (such as those mentioned in the previous paragraph) can make this difficult, Moriarty argues that the core virtues of objectivity and care should be practiced by engineers. Caring and being objective on a consistent basis, he claims, will enable engineers to make the right decisions in most circumstances.

Mike W. Martin discusses the issue of whistleblowing, which can arise in any profession but is particularly relevant in engineering where safety concerns are common. Whistleblowing is generally understood to occur when an employee goes outside the company (to the press, for example) in order to shed light on misconduct within the company. The label "blowing the whistle" comes from the effort to get the public's attention, and when this occurs in engineering it is typically in order to alert the public to a potentially unsafe product. An engineer would take this step when his boss (or bosses) allowed a product to sell despite the engineer's concerns; the manager, having the responsibility to make a reasonable profit, might not make safety the priority. The engineer must then decide whether to blow the whistle, which could prevent harm (and even deaths) but might well ruin his career, since "tattling" on one's company is seen as the worst form of disloyalty. Martin reviews some common ethical approaches to whistleblowing, which tend to emphasize the conflict between the duty of safety owed to the public on one hand and the duty of loyalty owed to one's company on the other. He then argues that there is another important consideration—an engineer's rights as a *person* and his responsibilities to family and others outside the workplace. This is certainly relevant, Martin claims, since whistleblowing seriously jeopardizes the whistleblower's income and livelihood. Martin concludes by recommending a virtue-based approach to this important ethical issue.

The question of engineers' obligations to the public is then taken up by Taft Broome, Jr. While engineers indeed have certain duties of loyalty and even certain duties to maintain the business, it is a commonly held view that engineers, as professionals, owe their primary obligations to the public. However, competing interests and personal considerations of the sort already discussed can make fulfilling public obligations difficult. Whether it is possible for engineers to hold public interests paramount depends, in part, on just what is meant by the "public" and thus "public paramountcy." It also depends on what is meant by "engineering," which has traditionally been considered a field of applied science. Broome offers his views about these meanings and points out that risk to the public is an inherent part of engineering. The health and welfare of the public cannot be guaranteed, and so a qualified view of public paramountcy will be that engineers must hold acceptable risk—not assurance of safety (which is impossible and even contradictory)—to be paramount.

Loyalty, meanwhile, is discussed by Eugene Schlossberger in the context of trade secrets and patents. When an engineer changes companies, she brings to the second company information she acquired while at the first, and this raises certain ethical questions. Engineering firms compete with each other on the basis of information. Research and development is necessary to generate the information, which in turn leads to the development of new or improved products. Thus, we can imagine one company spending money to do research and learning information, and another company "stealing" that information, enabling it to make the products without having to do any research. Such stealing seems wrong, of course, but when an engineer simply gives her new company information learned at her old company, the effect is the same. In analyzing this issue, Schlossberger describes different types of information, and he explains why some types are rightly the property of the previous company while other types are rightly the property of the engineer herself.

Many of the ethical questions raised in the engineering profession are covered in the final article. Robert E. McGinn describes a case involving different stages of development in the engineering of composite bicycles. While the case might initially seem straightforward, it encompasses several ethical issues, and McGinn reviews each in turn. These include issues pertaining to conflicts of interest, efficiency, safety, and information disclosure. The details covered by McGinn demonstrate how easily ethical problems can arise in engineering, even when the situation seems uncomplicated.

Ethics, *Ethos*, and the Professions: Some Lessons from Engineering

GENE MORIARTY

Introduction

Ethical issues arise out of professional practice. Ethical theory can he brought to bear on these issues and can help the professional make ethical decisions by providing a conceptual framework within which the issues can be clarified. However, it is also true that ethical decisions are often arrived at without reference to ethical theory, or even to professional codes of ethics which typically embody a variety of ethical theories. The professional person (lawyer, physician, engineer, etc.) often decides what to do intuitively, simply on the basis of his or her character or ethos. If that person is, for example, a caring and objective physician, then he or she would no doubt exercise his or her medical knowledge and skills in a caring and objective manner.

The word *ethos* "originally meant customs (of a group) and later was associated with character."[1] In addition to a group ethos, an individual ethos and a global ethos can be distinguished. I will not take up the question of global ethos, but will argue that a group ethos or character of a particular kind emerges out of the practice of particular kinds of virtues (or vices). And, of course, groups are composed of individuals. A practicing professional is always both an individual as well as a member of a profession. But I will be less concerned with individuals as individuals, and more concerned with individuals as group members. Certainly, most engineering practice these days entails a group effort. For product development, for instance, an engineering group or team might need a diversity of expertise in the areas of circuit design, modeling, simulation, testing, layout, integrated circuit fabrication and packaging.

Is there a character or ethos of engineering? The ethos of engineering is the ethos or character of the engineers as engineers, individually and collectively engaged in the enterprise of engineering. Of course, it is possible that an engineer may lead two or more different lives, being an ethical performer on the job, a real Dr. Jekyll, while being a Mr. Hyde at home, or vice versa. However, in general, the practice of virtues such as care and objectivity by any professional as a professional should help to shape his or her whole character and, in particular, should help to shape for the engineering profession collectively a caring and objective group ethos. In turn, as the ethos of the engineering profession becomes more caring and objective, individual engineers, in drawing from this ethos and living up to it, will become themselves more caring and objective. . . .

. . . Engineering is a practice inherently tied to a variety of values, some of which may be in conflict. Efficiency, for example, is highly valued in engineering practice. But defining efficiency narrowly (as, for example, the maximum of the output per unit input) may result in serious damage to the environment, the protection of which is also valued in engineering practice. In the face of the diversity of values important to engineering, I will argue that the explicit practice of the virtues of care and objectivity—as portrayed in the works of Haworth, Gilligan, Mayeroff and Noddings[2]—

[1]Sherwin Klein, "Platonic Virtue Theory and Business Ethics," *Business and Professional Ethics Journal*, Vol. 8, No. 4, 1990, p. 65.

[2]Lawrence Haworth, *Decadence and Objectivity* (Toronto: U. of Toronto P., 1977); Carol Gilligan, *In a Different Voice* (Cambridge, MA: Harvard U.P., 1982); Milton Mayeroff, *On Caring* (New York: Harper and Row, 1971); Nel Noddings, *Caring—A Feminine Approach to Ethics and Moral Education* (Berkeley, CA: U. of California P., 1984).

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constitutes a positive engineering ethos. Such an ethos, in turn, can provide a focus for the engineering profession.

The Problem

I will illustrate the problem at issue by a narrative from my personal history: I was brought up to feel that war was good for nothing, generally speaking, except making the rich people richer. But there I was, fresh out of graduate school, interviewing for an engineering job at a large aerospace company. The engineers in my prospective group were excitedly telling me about a system they were developing. It sensed the terrain with an ingenious radar mechanism, employed an elaborate feedback control structure, and made determinations on the basis of statistical decision rules. The job offered fascinating prospects for sophisticated engineering designs. But then I took a wider look at the project and realized that the system I'd be working on was to form part of the signal processing unit of what came to be the Cruise Missile. A dilemma indeed. Could I contribute to such a project and thereby to the militarization of the planet? This is not an uncommon problem in engineering: here is a technically sweet project whose intended use is, however, at best unsettling. What to do? My instincts told me to back down. I did (and was fortunate to get a better job later anyway).

Reflecting on this situation, I realized that I had not explicitly employed any ethical system of thought to guide my decision about a situation that had obvious ethical import. I didn't, for example, make the decision by seeking out the greatest good for the greatest number. I came to a decision based on my character—my internalized values or ethos. The problem is that this scenario wherein personal values rather than ethical systems guide ethical decisions appears to be quite common. What values, then, would be most positive for engineers and engineering? The values of an engineer are revealed in the character or ethos of that engineer. The values of engineering are revealed in the character or ethos of the engineering profession. Engineering ethics came into its own as a separate discipline in the late 1970s, focusing its concerns on codes of ethics. In contrast, I will emphasize virtue ethics, which links directly to character or ethos, not as a counter to traditional engineering ethics, but as a complement to it.

Ethos and Character

. . . While ethics is normative and associated with the "ought," ethos is primarily descriptive and associated with the "is." However, my contention is that engineering ought to be a caring and objective practice; care and objectivity *should* characterize the ethos of engineering. In other words, there is a normative element within the notion of ethos which implies that it is possible to *choose* one's ethos. In fact, postmodern philosophers such as Nietzsche tell us it is no longer possible to be purely descriptive: all description is really interpretation which incorporates an advocacy of some kind. I advocate, then, a specific ethical practice in accord with the virtues of care and objectivity for the sake of creating and instilling a specific kind of engineering ethos.

Ethos or character, exhibited in the practice of virtue and vice, is more than mere habit. Habit is largely unconscious, while character, though it may be exhibited in a seemingly unconscious act, requires conscious and often strenuous effort to develop. Character is a vigor, an energy, a tenor, a temper, a spirit, a fervor. Ralph Waldo Emerson said it best: "this is what we call Character—a reserved force that acts directly by presence, without means."[3]

In addition, character is often related to destiny. Destiny, but not fate. Though these words are often used synonymously, I will take "fate" as the given in one's life and "destiny" as what one does in the face of fate. My fate is given to me by my circumstances; it befalls me. I cannot change certain facts in my life, like when, where, and to whom I was born. My destiny, though, was to become an engineer. I could have been a librarian. Ethos or character as destiny, then, is how I choose to be in the face of my conditioning. The ethos of modern engineering is the way the engineering profession has chosen to be in response to the numerous predicaments it has confronted over the last several centuries.

[3]Ralph Waldo Emerson, *The Essays of Ralph Waldo Emerson* (New York: Random House, 1944), p. 270.

The character of engineering today is not very different than the character of 19th Century engineering. T. P. Hughes reports that the successful engineer, in contributing to the character of the engineering profession of the 19th Century, was "orderly, regular in his habits, disciplined, predictable, methodical in his problem solving, even-tempered, and law-abiding. He had brought order out of the chaos of his natural instincts."[4] Such was the ethos of engineering in the last century. Many of the virtues of this ethos are still essential to modern engineering.

Vices play a large negative role in ethos development. The vices that kept the 19th Century engineer from success included "sensuousness, self-indulgence, recklessness, untidiness and emotional outbursts."[5] Though these are generally still considered vices in engineering, the role of the emotions, for example, in the modern engineer is seen in a much more positive light. This is especially true in view of the need for expressing feelings and intuitions as part of the creativity of engineering design.

Wendell Berry, farmer, poet and essayist, believes that the main obstacle to character development is the vice of specialization.[6] Yet, to some degree, engineers need to specialize. The profession requires it. Although Berry seems pessimistic about the possibility that any specialized person can live a meaningful life, engineering students are supposed to be able to counter and augment their specialized training with a broad-based general education. The recent general education debates, capturing much attention in academe, should no doubt engage more engineers and engineering educators. Of course, the engineer should be nothing less than the modern Renaissance person, tastefully integrating specialized training with general education.

Ethics to Ethos

Engineering ethics is a type of applied ethics in that whenever engineering ethics is employed in an engineering situation, the conceptual apparatus of ethical theory is brought to bear on the situation in an attempt to understand, if not to answer the question "what ought to be done?" By clarifying the ethical dimensions of particular issues, engineering ethics can assist in forming appropriate ethical judgments about the situation at hand. Ethical theory comes in many guises. P. Aarne Vesiland distinguishes three kinds of ethics which are all in various ways rule based: deontological, utilitarian and environmental.[7] Deontological ethics bases decisions on presupposed notions such as "promises must always be kept" or "lying is wrong." Any ethical situation that arises would then have to be dealt with on the basis of these presuppositions, without regard for consequences. Utilitarian ethics, which is a type of ethics called consequentialism, assumes that one should always seek the greatest good for the greatest number of people. It would, for example, not require that a promise be kept if the greater good can be achieved by breaking it. Environmental ethics can be either deontological or utilitarian, but with the added feature that the environment now has a stake in ethical decisions. The greatest good, for example, must include nature or the environment as a beneficiary.

As conceptually interesting and coherent as these rule-based systems of ethics might be, they have lately come into question, not because they are not *useful*, but rather because they are not *used*. In fact, one study concluded that most engineers do not explicitly follow a code or system of ethics when responding to ethical situations; they respond instead in an intuitive, spontaneous way in accord with their character or ethos.[8]

Though a given system of ethical rules might in fact be highly coherent, it often appears ambiguous and produces an ambivalence on the part of the average engineer. How, then, to help engineers deal with matters of ethical import? Part of the answer is to re-double efforts to teach traditional codes of engineering ethics. The rest of the answer can be found in another kind of ethics, *virtue*

[4] T. P. Hughes, introduction to *Selections from Lives of the Engineers*, by Samuel Smiles (Cambridge, MA: MIT Press, 1966), p. 11.

[5] Ibid.

[6] Wendell Berry, *The Unsettling of America* (New York: Avon, 1977), p. 19.

[7] P. Aarne Vesiland, "Rules, Ethics and Morals in Engineering Education," *Engineering Education*, Vol. 78, No. 5, 1988, p. 291.

[8] Roy V. Hughson and Philip M. Kohn, "Ethics," *Chemical Engineering*, Sept. 22, 1980, p. 132.

ethics, an approach based largely on Aristotle's *Nicomachean Ethics* and, to a lesser extent, on Plato's *Republic*. Virtue ethics focuses on the agent's character in contrast to rule-based ethics which focuses on the agent's acts. Of course, the agent is the one who acts and the act is the act of an agent. The two cannot be separated though they can be distinguished.

Joel Kupperman maintains that in general the agent's character is a complex web of involvements which includes the presence or absence of:

(1) dispositions to recognize certain situations as ethically problematic;

(2) dispositions to treat certain factors as having special weight in ethical decisions;

(3) concerns for certain things thought to matter;

(4) commitments that provide a connecting thread among different moments of the agent's life.[9]

Commitments, concerns, and dispositions all play a role in the formation of ethos.

A number of important attitudes, dispositions or virtues appear as motifs in the following story: I once did an engineering consulting job for a company that designed and developed an ultrasound body-scanning device for medical applications. The problem was to design a compensator circuit to stabilize an actuator whose dynamic operation had to be very fast but still smooth enough to allow for accurate readings. I tried to recall what qualities of character, constituting or at least contributing to my ethos, I needed to complete the design. I needed knowledge, to be sure, both intuitive knowledge of what ballpark values to use in choosing compensator gains and explicit conceptual knowledge of design procedures, like Nyquist and Root-Locus techniques. I had to look at the problem objectively and fairly size up the constraints, especially those due to cost and the short time I was given to come up with a solution. This required alternating between a broad, holistic perspective and a focused, detailed manipulation of relevant parameters. Also, I had to trust the people I was working with even though I didn't know them personally. They provided me with a reliable mathematical model of the device and, of course, I had to trust their judgment in arriving at the complex set of equations that constituted the model. *Trust, knowledge, alternating perspectives* and a sense of *objective fairness* were all involved and all contributed to the character I needed to engineer the problem at hand.

Many of the virtues indicated in this example will re-appear as part of the proposed virtue ethic of care and objectivity I will shortly detail. The practice of such a system of virtues should lead to an ideal pattern of character, an ideal ethos.

Practice

A single good act does not a good person make. Practice makes perfect. Though a person may be naturally inclined to lead a good life, generally a good character will emerge only by following a virtue ethic of some kind, in a more or less explicit fashion. A practice, of course, is an act and acts fall typically within the domain of rule-based ethics while virtue ethics focuses on the agent and considers the character of the agent involved in the practice. Within the practice of engineering, then, virtue ethics and rule-based ethics tend to coalesce. Hence, codes of ethics in which rules, standards and ideals of the engineering profession are most explicitly formulated should reflect the virtues that indicate the good engineer. An engineer, for instance, who practices in accord with a code of ethics should become a caring and objective engineer, while a caring and objective engineer would no doubt abide by the code of ethics of his or her discipline.

Along these lines, David Braybrooke discusses the virtue of *epieikeia*, which is a Greek word meaning roughly having a disposition to adjust rules to circumstances. For example, "The rule is that one must repay a loan when it falls due; but *epieikeia* dictates that it not be repaid when someone has gone mad and would put the money, or the borrowed article, to evil use."[10] The point, for our purposes, is that the virtue of *epieikeia* presupposes the existence of rules in order to be mani-

[9]Joel Kupperman, "Character and Ethical Theory," *Midwest Studies in Philosophy*, Vol. 13, 1988, p. 116.

[10]David Braybrooke, "No Rules Without Virtues: No Virtues Without Rules," Social Theory and Practice, Vol. 17, No. 2, 1991, p. 144.

fested. Braybrooke goes on to show how moral rules presuppose the enactment of virtues in order for the rules to take shape. Engineering codes of ethics, then, in order to take the shape they do and to serve as guidelines for the ethical practice of engineering, must presume that the people who worked out their formulation acted in a virtuous fashion, for example, exhibiting the virtues of care and objectivity. A further discussion of how virtues relate to engineering codes of ethics is a topic for a future investigation.

Previously, the notion of virtue meant something like disposition. Now we will take it in a more dynamic sense: a virtue is a practice in search of an excellence, which, of course, presupposes a disposition to engage in the practice in the first place. Alasdair MacIntyre defines virtue as "an acquired human quality the possession and exercise of which tends to enable us to achieve those goods which are internal to practices and the lack of which effectively prevents us from achieving any such goods."[11]

Crucial to MacIntyre's analysis is the distinction between internal and external goods. Money, for example, is an external good that might come from the practice of baseball. But an external good is a good that can be achieved by engaging in other activities as well, like playing the stock market.

> On the other hand, there are goods internal to the playing of baseball that cannot be explained, experienced, or understood apart from the specific context of the practice. For example, becoming an excellent line-drive hitter is an internal good in baseball."[12]

An example from engineering of an internal good: becoming an expert or even a virtuoso in the implementation of microprocessor controls for a wide variety of engineering situations. Having that proficiency is a good in itself. But an engineer can *use* this internal good to achieve an external good, like fame, by presenting papers at conferences or writing textbooks. Another example takes engineering broadly as a social practice: an internal good would be to engineer and build roads that are aesthetically in harmony with the environment. An external good associated with this activity would be money, like the salary a typical civil engineer earns.

In light of these examples we can distinguish between an engineer practicing as an individual and practicing as a member of a collective. Seung in fact takes MacIntyre to task for ignoring the role of the individual engaged in practices.[13] Nevertheless, for our purposes, the practice of engineering is most accurately viewed as a collective practice with a collective sharing of common standards. Gone are the days of the isolated eccentric laboring away in *his* cubical without need for human contact. The engineer today is inevitably part of a group or team assigned a project with a deadline all overseen by a group leader. The ethos of engineering is the ethos of engineers practicing as engineers. And that generally means practicing collectively. This is not to belittle the achievements of individual engineers. Their acquisition of skills is an essential element in modern engineering practice. The point is that their skills are never truly possessed unless they are exercised and that exercise is invariably a collective enterprise.

The collective practice of engineering must be distinguished from the institution of engineering. The collective practice aims at internal goods. The institution aims at external goods. Institutions form the necessary context for the practice. They are "structured in terms of power and status, and they distribute money, power, and status as rewards."[14]

The pursuit of external goods does not require the exercise of any special virtues, but depends on ambition and self-interest, natural human drives that institutions organize and channel. The problem is that even though the pursuit of external goods through its institutions is a necessary part of engineering practice, the pursuit of internal goods and the engagement of the virtues in engineering practice might

> bar us from being rich or famous or powerful. Thus although we may hope that we can not only achieve the standards of excellence and

[11]Alasdair MacIntyre, *After Virtue*, 2nd ed. (Notre Dame: U. of Notre Dame P., 1984), p. 191.

[12]Randolph Feezell, "Sport, Character, and Virtue," *Philosophy Today*, Vol. 33, Nos. 3 & 4, 1989, p. 205.

[13]T. K. Seung, "Virtues and Values: A Platonic Account," *Social Theory and Practice*, Vol. 17, No. 2, 1991, p. 220.

[14]MacIntyre, op. cit., p. 194.

> the internal goods of certain practices by possessing the virtues and become rich, famous and powerful, the virtues are always a potential stumbling block to this comfortable ambition.[15]

The possible conflict between internal and external goods is a serious concern, but the possible conflict between different types of internal goods is even more serious. The question of goods internal to engineering is complicated by the fact that the engineer is engaged in a practice that has various dimensions which often exhibit value conflicts. Like many a modern engineer, physicist J. Robert Oppenheimer was attracted to a problem that to him was technically sweet but morally repugnant: nuclear weapons work. Oppenheimer was enthralled by nuclear science but "he was also deeply troubled about atomic weapons and sought to delay the hydrogen bomb programme while avenues for arms control were explored."[16] The question seems to be: how can engineers, while exercising technical virtuosity, design and create devices, structures and systems that influence society in ways that enhance the social good? The social good is an internal good of engineering practice that should take precedence over other forms of internal goods. Most engineering codes of ethics give the highest priority to the health, safety and welfare of society.

Care and Objectivity

Engineers should practice the virtues of care and objectivity in order that an ideal character or ethos of engineering might emerge. Their practice will no doubt be motivated by the external goods of money, power and fame; yet, this motivation should not be unbridled, rather it should be guided by both virtuosity values and social values in pursuing internal goods. Edmund Pincoff suggests that persistence, courage and unflappability in the face of setbacks are desirable instrumental virtues, and tolerance and tact are desirable diplomatic virtues.[17] These virtues seem to speak to the needs of the engineer and many of them fall under the broad heading of care and objectivity, which are the virtues I have been suggesting engineers ought to practice. I will now elaborate upon my suggestion.

Objectivity is delineated not merely as the disposition of treating things as objects, but also, and essentially, as the disposition of fairness and all that that connotes. Following Lawrence Haworth, I wish to dispel the idea of a narrow objectivity which includes connotations such as coldness, lack of concern, bureaucracy, and the pursuit only of economic efficiency. I will advocate his broad notion of objectivity:

> Objectivity is used as an approximate synonym for impartiality or fairness, understood as a personal outlook or stance, with the added connotation of one's being oriented outwards, on *objects,* and of locating the significance of one's life in those objects rather than in their impact on oneself or on the groups with which one identifies.[18]

To be objective is *not* to be aloof, uninvolved or uncommitted. It is to be disinterested rather than uninterested:

> To be objective is to be committed in a way that takes adequate account of all the relevant factors. To resolve an issue objectively or disinterestedly is to set aside one's biases and special interests and to be influenced only by the facts, interests, and beliefs that are relevant to the issue. It is to decide the matter on its own merits. Objectivity as a trait of character is a standing disposition to react that way. Every person exhibits the disposition in some degree, but no one exhibits it consistently or totally.[19]

My proposal is that engineers embrace this kind of circumspect objectivity as a contribution to a positive professional engineering ethos. Though most engineers are so inclined to some degree, I want to designate this sense of objectivity as an explicit ingredient in the proposed virtue ethic. This kind of objectivity, practiced as a virtue, seems to provide the conditions that make possible an open-minded consideration of rule-based

15 Ibid., p. 196.

16 Arnold Pacey, *The Culture of Technology* (Cambridge, MA: MIT Press, 1983), p. 125.

17 Edmund L. Pincoffs, *Quandaries and Virtues* (Lawrence, KS: U. of Kansas P., 1986), p. 6.

18 Haworth, op. cit., p. x.

19 Ibid., p. 100.

ethical systems, such as codes of engineering ethics. The grounding of engineering codes of ethics in objectivity and the objectivity implied by adherence to these codes are important additional considerations.

This notion of objectivity refers to a self-transcendence which provides the conditions that in fact make social ethical life possible. I become more than myself by affirming my individuality but at the same time affirming my connection to the other beings in my world of involvements, my social world. The objective engineer practices in a socially responsible way. Such practice "directs the person outwards, toward other persons and objects to which value is attributed, and the self affirmed through the activity is one defined by its relationship with those persons and objects."[20]

For example, a positive engineering solution to the problem of land erosion calls for an objective attitude toward grazing land. Many ranchers graze cattle in small fenced-in areas. The cattle are easier to control this way. The problem is that the cattle in such circumstances tend to eat all the greenery, which leaves nothing to hold the topsoil together, causing erosion of the soil. Agricultural engineers, working perhaps as a consulting team and hired by the ranchers, might suggest to the ranchers that the solution to their erosion problem is to graze the cattle in much larger areas. Cattle will then only eat the greenest grass and leave much foliage that will hold the topsoil together. Of course, this solution is expensive. Can ranchers afford it? Can they afford not to?

The view of land as a resource that has value only to the rancher who owns it must be expanded "objectively" to be able to see the land as having value in its own right and to persons and animals other than the owner. Such a view might decrease short-term profits to the owner and thus be seen to be in opposition to the pursuit of their external goods. Most ranchers are business people who aim to make money. The consulting engineers in our example are also in business to make money, but for them to act as true professionals seriously engaged in objective engineering practice, they must look at the erosion problem with the widest possible perspective. That invariably implies that they recommend environmental responsibility, the long-term approach, over the short-term profit motive. Tradeoffs will be necessary. . . .

. . . Earlier, virtues were defined as qualities necessary to achieve the goods internal to practices. Practicing the virtue of objectivity leads to a self-transcendence which opens up the context of engineering practice so we see that internal "goods can only be achieved by subordinating ourselves within the practice in our relationship to other practitioners."[21] As practicing engineers, we are always already in "relationships to those other people with whom we share the kind of purposes and standards which inform practices."[22]

Virtues, therefore, are not only qualities necessary to achieve the goods internal to practices, but virtues are also the qualities contributing to the good of one's whole life, and virtues are related to the pursuit of human goods the conception of which can only be elaborated and possessed within a continuing social tradition. The virtue of objectivity, then, when practiced in its fullest sense, requires recognition of the community of other practitioners as well as the social tradition in which engineering practice is embedded. Within these conjunctions, objectivity evokes the virtue of care.

Care in the widest sense links humans to their world. I care about X and X is thereby incorporated into my world, my context of involvements, which in turn grounds and conditions me. Care is connective. It flows along the threads of the web of relationships, the web that takes "life as dependent on connection, as sustained by activities of care, as based on a bond of attachment rather than a contract of agreement."[23] Carol Gilligan detects "an entirely different approach to the ethical life than acting on universal principles. This is the different voice she is concerned to hear and to elaborate in her book."[24] The different voice is the voice of care, "doing spontaneously whatever the situation demands."[25]

[20]Ibid., pp. 91–92.

[21]MacIntyre, op. cit., p. 91.

[22]Ibid., p. 91.

[23]Gilligan, op. cit., p. 57.

[24]Hubert L. Dreyfus and Stuart E. Dreyfus, "Toward a Phenomenology of Ethical Expertise," *Human Studies*, Vol. 14, 1991, p. 245.

[25]Ibid., p. 246.

Though it is generally the case that the male voice responds more to the universal principles of rule-based ethics and the female voice to the ethics of care, Gilligan maintains that:

> the different voice I describe is characterized not by gender but by theme. Its association with women is an empirical observation, and it is primarily through women's voices that I trace its development. But this assertion is not absolute, and the contrasts between male and female voices are presented here to highlight a distinction between two modes of thought and to focus a problem of interpretation rather than to present a generalization about either sex."[26]

Nel Noddings elaborates on Gilligan's Ethics of Care, providing distinctions and definitions for a philosophical analysis of care. Noddings distinguishes the care-giver as the "one-caring" from the recipient as the "cared-for." She insists that "both parties must contribute to this relation if caring is to be complete."[27] Noddings also observes that "our obligation to summon the caring attitude is limited by the possibility of reciprocity. We are not obliged to act as one-caring if there is no possibility of completion in the other."[28] This implies that ethical caring is restricted to the human domain. As we move from the human level to the animal level to the plant level to the thing and idea level, we move "steadily away from the ethical toward the sensitive and aesthetic."[29] We can have a kind of non-ethical caring for beings that are not members of the human race. . . .

. . . Mayeroff's notion of care implies a host of other virtues: knowing (implicit as well as explicit knowing), patience, honesty, trust, humility, hope, courage and what he calls "alternating rhythms" (moving back and forth between a narrower and wider perspective on a given problem). The virtue of objectivity, considered in the comprehensive manner presented previously, resonates with many of the virtues that Mayeroff's notion of care implies.

[26]Gilligan, op. cit., p. 2.
[27]Ann Diller, "The Ethics of Care and Education" (book review), *Curriculum Inquiry*, Vol. 8, No. 3, 1988, p. 327.
[28]Noddings, op. cit., p. 149.
[29]Ibid., p. 161.

An example: Last year I had a graduate student who completed her MS final project under my supervision. I wanted to consider the possible application of an area of optimal control theory (H-infinity control theory) of which I had heard good things but about which I knew very little. The theory is very complex, very abstract, but also very fertile. A major part of our work was to read research papers together and discuss the ideas and eventually focus on a concrete project. We had to *fairly* and *objectively* size up the existing field of H-infinity control theory. That in itself was no small task. *Patience* was paramount. We encountered a wealth of complicated equations and new ideas that had to be *nurtured* and allowed to grow at their own pace. The rigor and abstraction of the math involved required *humility* of us both. There was always a deeper level of understanding that escaped us. But we remained undaunted and held on to *hope* as "an expression of the plenitude of the present, a present alive with a sense of the possible." We employed *alternating rhythms*, moving back and forth from a very specialized focus to the concrete realm of applying the theory to models of real physical systems. And though we started out *knowing* very little about this specialized area, we drew from and built on the knowledge we had (explicit and implicit) of classical and modern control theory. Many aspects of the virtues of care and objectivity, then, were at work (and play) in our explorations. (We did find an interesting project which my student completed just before the deadline.)

A virtue ethic, I propose, headlining care and objectivity should promote an ideal ethos for the engineering profession. How does one take on such an ethic? No complicated calculations are required. Simply begin to be and act in a more caring and more objective way.

Conclusions

Traditional rule-based engineering ethics should continue to be studied, developed and applied whenever appropriate. But virtue ethics, emphasizing care and objectivity, as well as the idea of ethos also deserve consideration by those concerned with engineering ethics.

Is there a common ethos that informs engineering practice? There seems to be an abundance of different ethe (plural of ethos) that individual engineers bring to their practice. This is only to be expected with the increasingly multicultural background of modern engineers. The hegemony of the white male constituency of the engineering profession has altered considerably in the last few decades with the influx of Middle Eastern, East Indian, and Asian students into engineering schools around the world. (The problem of attracting more women and minority students to the profession is still outstanding.) Though this pluralism of backgrounds and ethe seems, for the most part, to be consonant, at least relative to the practice of engineering, there appears to be a lack of cohesiveness that can gather and focus the diverse takes on the modern engineering enterprise.

My proposal is that the practice of the virtues of care and objectivity can provide a focus for the engineering profession. The practice of engineering in a caring and objective manner can benefit the person as engineer and dignify the engineer as person, as well as provide a positive focus for the profession. In order to practice the specifics of a particular task in harmony with a positive virtue ethics, we must aim not merely at external goods such as money, power and fame, but also at internal goods such as virtuosity (in a given area or discipline) and social consciousness. Seeking such internal goods in a caring and objective manner should help to ennoble engineering practice, as the practice exhibits a more salutary influence upon the society in which it is embedded. . . .

Discussion Questions

1. Moriarty claims to advocate a specific ethical practice. What does he mean and which ethical practice does he advocate? What does he mean by an *ethos* and what is his view of character?
2. What is the role of rule-based ethical theories in the life of the average engineer? According to Moriarty, how does an engineer make moral decisions?
3. How would we account for an engineer who knows nothing about moral theory but who still makes ethically sounds decisions?
4. What is the relationship among the collective practice of engineering, the institution of engineering, and the practice of the individual engineer?
5. According to Moriarty, what are the virtues that engineers ought to practice? What does this mean for the actions of the individual engineer?

Whistleblowing: Professionalism and Personal Life

MIKE W. MARTIN

Introduction

I want to take a fresh look at whistleblowing, in order to draw attention to some neglected issues concerning the moral relevance of personal life to understanding professional responsibilities. Specifically, the issues concern: personal right and responsibilities in deciding how to meet professional obligations; increased personal burdens when others involved in collective endeavors fail to

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meet their responsibilities; the role of the virtues, especially personal integrity, as they bear on "living with oneself"; and personal commitments beyond minimum requirements.

Let me bring to mind three well-known cases.

(1) In 1972 Dan Applegate wrote a memo to his supervisor, the vice-president of Convair Corporation, telling him in no uncertain terms that the cargo door for the DC-10 airplane was unsafe, making it "inevitable that, in the twenty years ahead of us, DC-10 cargo doors will come open and I would expect this to usually result in the loss of the airplane." As a subcontractor for McDonnell Douglas, Convair had designed the cargo door and the DC-10 fuselage. Applegate was Director of Product Engineering at Convair and the senior engineer in charge of the design. His supervisor did not challenge his technical judgment in the matter, but told him that nothing could be done because of the likely costs to Convair in admitting responsibility for a design error that would need to be fixed by grounding DC-10s. Two years later, the cargo door on a Turkish DC-10 flying near Paris opened in flight, decompressurizing the cargo area so as to collapse the passenger floor—along which run the controls for the aircraft. All 346 people on board died, a record casualty figure at that time for a single-plane crash. Tens of millions of dollars were paid out in civil suits, but no one was charged with criminal or even unprofessional conduct.

(2) Frank Camps was a principal design engineer for the Pinto. Under pressure from management he participated in coaxing the Pinto windshield through government tests by reporting only the rare successful test and by using a Band-Aid fix design that resulted in increased hazard to the gas tank. In 1973, undergoing a crisis of conscience in response to reports of exploding gas tanks, he engaged in internal whistleblowing, writing the first of many memos to top management stating his view that Ford was violating federal safety standards. It took six years before his concerns were finally incorporated into the 1979 model Pinto, after nearly a million Pintos with unsafe windshields and gas tanks were put on the road. Shortly after writing his memos he was given low performance evaluations, then demoted several times. He resigned in 1978 when it became clear his prospects for advancement at Ford were ended. He filed a lawsuit based in part on age discrimination, in part on trying to prevent Ford from making him a scapegoat for problems with the Pinto, and in part on trying to draw further attention to the dangers in the Pinto.

(3) On January 27, 1986, Roger Boisjoly and other senior engineers at Morton Thiokol firmly recommended that space shuttle *Challenger* not be launched. The temperature at the launch site was substantially below the known safety range for the O-ring seals in the joints of the solid rocket boosters. Top management overrode the recommendation. Early in the launch, the *Challenger* boosters exploded, killing the seven crew members, to the terrified eyes of millions who watched because schoolteacher Christa McAuliffe was aboard. A month later Boisjoly was called to testify before the Rogers Commission. Against the wishes of management, he offered documents to support his interpretation of the events leading to the disaster—and to rebut the interpretation given by his boss. Over the next months Boisjoly was made to feel increasingly alienated from his coworkers until finally he had to take an extended sick leave. Later, when he desired to find a new job he found himself confronted with companies unwilling to take a chance on a known whistleblower.

As the last two cases suggest, there can be double horrors surrounding whistleblowing: the public horrors of lost lives, and the personal horror of responsible whistleblowers who lose their careers. Most whistleblowers undergo serious penalties for "committing the truth." One recent study suggests that two out of three of them suffer harassment, lowered performance evaluations, demotions, punitive transfers, loss of jobs, or blacklisting that can effectively end a career.[1] Horror stories about whistleblowers are not the exception; they are the rule.

Three Approaches to Whistleblowing Ethics

The literature on whistleblowing is large and growing. Here I mention three general approaches. The first is to condemn whistleblowers as disloyal troublemakers who "rat" on their

[1] See, e.g., Myron P. Glazer and Penina Migdal Glazer, *The Whistleblowers* (New York: Basic Books, 1989).

companies and undermine teamwork based on the hierarchy of authority within the corporation. Admittedly, whistleblowers' views about safety concerns are sometimes correct, but final decisions about safety belong to management, not engineers. When management errs, the corporation will eventually pick up the costs in lawsuits and adverse publicity. Members of the public are part of the technological enterprise which both benefits them and exposes them to risks; when things go wrong they (or their surviving family) can always sue.

I once dismissed this attitude as callous, as sheer corporate egoism that misconstrues loyalty to a corporation as an absolute (unexceptionless) moral principle. *If*, however—and it is a big "if"—the public accepts this attitude, as revealed in how it expresses its will through legitimate political processes, then so be it. As will become clear later, I take public responsibilities seriously. If the public refuses to protect whistleblowers, it tacitly accepts the added risks from not having available important safety information. I hope the public will protect the jobs of whistleblowers; more on this later.

A second approach, insightfully defended by Michael Davis,[2] is to regard whistleblowing as a tragedy to be avoided. On occasion whistleblowing may be a necessary evil or even admirable, but it is always bad news all around. It is proof of organizational trouble and management failure; it threatens the careers of managers on whom the whistle is blown; it disrupts collegiality by making colleagues feel resentment toward the whistleblower, and it damages the important informal network of friends at the workplace; it shows the whistleblower lost faith in the organization and its authority, and hence is more likely to be a troublemaker in the future; and it almost always brings severe penalties to whistleblowers who are viewed by employers and colleagues as unfit employees.

I wholeheartedly support efforts to avoid the need for whistleblowing. There are many things that can be done to improve organizations to make whistleblowing unnecessary. Top management can—and must—set a moral tone, and then implement policies that encourage safety concerns (and other bad news) to be communicated freely. Specifically, managers can keep doors open, allowing engineers to convey their concerns without retribution. Corporations can have in-house ombudspersons and appeal boards, and even a vice-president for corporate ethics. For their part, engineers can learn to be more assertive and effective in making their safety concerns known, learning how to build support from their colleagues. (Could Dan Applegate have pushed harder than he did, or did he just write a memo and drop the matter?) Professional societies should explore the possibility of creating confidential appeal groups where engineers can have their claims heard.

Nevertheless, this second approach is not enough. There will always be corporations and managers willing to cut corners on safety in the pursuit of short-term profit, and there will always be a need for justified whistleblowing. Labeling whistleblowing as a tragedy to be avoided whenever possible should not deflect attention from issues concerning justified whistleblowing.

We need to remind ourselves that responsible whistleblowing is *not* bad news all around. It is very good news for the public which is protected by it. The good news is both episodic and systematic. Episodically, lives are saved directly when professionals speak out, and lives are lost when professionals like Dan Applegate feel they must remain silent in order to keep their jobs. Systematically, lives are saved indirectly by sending a strong message to industry that legally-protected whistleblowing is always available as a last resort when managers too casually override safety concerns for short-term profits. Helpful pressure is put on management to take a more farsighted view of safety, thereby providing a further impetus for unifying corporate self-interest with the production of safe products. In the DC-10, Pinto, and *Challenger* cases, management made shortsighted decisions that resulted in enormous costs in lawsuits and damaged company reputations.

In this day of (sometimes justified) outcry over excessive government regulation, we should not forget the symbolic importance of clear, effective, and enforced laws as a way for society to express its collective vision of a good society. Laws protecting responsible whistleblowing express the community's resolve to support professionals who act

[2]Michael Davis, "Avoiding the Tragedy of Whistleblowing," *Business & Professional Ethics Journal* Vol. 8, No. 4 (Winter, 1989): 3–19.

responsibly for public safety. Those laws are also required if the public is to meet its responsibilities in the creation of safe technological products, as I will suggest in a moment.

A third approach is to affirm unequivocally the obligation of engineers (and other professionals) to whistleblow in certain circumstances, and to treat this obligation as paramount—as overriding all other considerations, whatever the sacrifice involved in meeting it. Richard De George gave the classical statement of this view.[3] External whistleblowing, he argued, is obligatory when five conditions are met (by an engineer or other corporate employee):

1. "Serious and considerable harm to the public" is involved;
2. one reports the harm and expresses moral concern to one's immediate superior;
3. one exhausts other channels within the corporation;
4. one has available "documented evidence that would convince a reasonable, impartial observer that one's view of the situation is correct"; and
5. one has "good reasons to believe that by going public the necessary changes will be brought about" to prevent the harm.

De George says that whistleblowing is morally *permissible* when conditions 1–3 are met, and is morally *obligatory* when 1–5 are met.

As critics have pointed out, conditions (4) and (5) seem far too strong. Where serious safety is at stake, there is some obligation to whistleblow even when there are only grounds for hope (not necessarily belief) that whistleblowing will significantly improve matters, and even when one's documentation is substantial but less than convincing to every rational person.[4] Indeed, often whistleblowing is intended to prompt authorities to garner otherwise unavailable evidence through investigations.

Moreover, having a reasonable degree of documentation is a requirement even for permissible whistleblowing—lest one make insupportable allegations that unjustifiably harm the reputations of individuals and corporations. So too is having a reasonable hope for success—lest one waste everyone's time and energy.[5] Hence, De George's sharp separation of requirements for permissibility and obligation begins to collapse. There may be an obligation to whistleblow when 1–3 are met and the person has some reasonable degree of documentation and reasonable hope for success in bringing about necessary changes.

My main criticism of this third approach, however, is more fundamental. I want to call into question the whole attempt to offer a general rule that tells us when whistleblowing is mandatory, *tout court*. Final judgments about obligations to whistleblow must be made contextually, not as a matter of general rule. And they must take into account the burdens imposed on whistleblowers.[6]

The Moral Relevance of Personal Life to Professional Duty

In my view, there is a strong *prima facie* obligation to whistleblow when one has good reason to believe there is a serious moral problem, has

[3]The quotes are from Richard T. De George's most recent statement of his view in *Business Ethics*, 3d ed. (New York: Macmillan Publishing, 1990), pp. 208–212. They parallel his view as first stated in "Ethical Responsibilities of Engineers in Large Organizations," *Business & Professional Ethics Journal* Vol. 1, No. 1 (Fall 1981): 1–14. As an example of a far higher demand on engineers see Kenneth D. Alpern, "Moral Responsibility for Engineers," *Business & Professional Ethics Journal* Vol. 2, No. 2 (Winter 1983): 39–47.

[4]Gene G. James, "Whistle Blowing: Its Moral Justification," in W. Michael Hoffman and Jennifer Mills Moore (eds.), *Business Ethics*, 2d ed. (New York: McGraw-Hill, 1990), pp. 332–344.

[5]David Theo Goldberg, "Tuning in to Whistle Blowing," *Business & Professional Ethics Journal* Vol. 7, No. 2 (Summer, 1988): 85–94.

[6]As his reason for conditions (4) and (5), De George cites the fate of whistleblowers who put themselves at great risk: "If there is little likelihood of his success, there is no moral obligation for the engineer to go public. For the harm he or she personally incurs is not offset by the good such action achieves." ("Ethical Responsibilities of Engineers in Large Organizations," p. 7.) Like myself, then, he sees the personal suffering of whistleblowers as morally relevant to understanding professional responsibilities, even though, as I go on to argue, he invokes that relevance in the wrong way.

exhausted normal organizational channels (except in emergencies when time precludes that), has available a reasonable amount of documentation, and has reasonable hope of solving the problem by blowing the whistle. Nevertheless, however strong, the obligation is only *prima facie:* It can sometimes have exceptions when it conflicts with other important considerations. Moreover, the considerations which need to be weighed include not only *prima facie* obligations to one's employer, but also considerations about one's personal life. Before they make all-things-considered judgments about whether to whistleblow, engineers may and should consider their responsibilities to their family, other personal obligations which depend on having an income, and their rights to pursue their careers.

Engineers are people, as well as professionals. They have personal obligations to their families as well as sundry other obligations in personal life which can be met only if they have an income. They also have personal rights to pursue careers. These personal obligations and rights are moral ones, and they legitimately interact with professional obligations in ways that sometimes make it permissible for engineers not to whistleblow, even when they have a *prima facie* obligation to do so. Precisely how these considerations are weighed depends on the particular situation. And here as elsewhere, we must allow room for morally reasonable people to weigh moral factors differently.

In adopting this contextual approach to balancing personal and professional obligations, I am being heretical. Few discussions of whistleblowing take personal considerations seriously, as being morally significant, rather than a matter of nonmoral, prudential concern for self-interest. But responsibilities to family and to others outside the workplace, as well as the right to pursue one's career, are moral considerations, not just prudential ones. Hence further argument is needed to dismiss them as irrelevant or always secondary in this context. I will consider three such arguments.

(i) The *Prevent-Harm Argument* says that morality requires us to prevent harm and in doing so to treat others' interests equally and impartially with our own. This assumption is often associated with utilitarianism, the view that we should always produce the most good for the most people. The idea is that even though engineers and their families must suffer, their suffering is outweighed by the lives saved through whistleblowing. Without committing himself to utilitarianism, De George uses a variation of the impartiality requirement to defend his criteria for obligatory whistleblowing: "It is not implausible to claim both that we are morally obliged to prevent harm to others at relatively little expense to ourselves, and that we are morally obliged to prevent great harm to a great many others, even at considerable expense to ourselves."[7]

The demand for strict impartiality in ethics has been under sustained attack during the past two decades, and from many directions. Without attempting to review all those arguments, I can indicate how they block any straightforward move from impartiality to absolute (exceptionless) whistleblowing obligations, thereby undermining the Prevent-Harm Argument. One argument is that a universal requirement of strict impartiality (as opposed to a limited requirement restricted to certain contexts) is self-demeaning. It undermines our ability to give our lives meaning through special projects, careers, and relationships that require the resources which strict impartiality would demand we give away to others. The general moral right to autonomy—the right to pursue our lives in a search for meaning and happiness—implies a right to give considerable emphasis to our personal needs and those of our family. [Thus] engineers' rights to pursue their meaning-giving careers, and the projects and relationships made possible by those careers, have relevance in understanding the degree of sacrifice required by a *prima facie* whistleblowing obligation.

(ii) The *Avoid-Harm Argument* proceeds from the obligation not to cause harm to others. It then points out that engineers are in a position to cause or avoid harm on an unusual scale. As a result, according to Kenneth Alpern, the ordinary moral obligation of due care in avoiding harm to others implies that engineers must "be ready to make greater personal sacrifices than can normally be demanded of other individuals."[8] In particular, according to Gene James, whistleblowing is required when it falls under the general obligation

[7]De George, *Business Ethics*, p. 214.

[8]Alpern, "Moral Responsibilities for Engineers," p. 39.

to "prevent unnecessary harm to others," where "harm" means violating their rights.[9]

Of course there is a general obligation not to cause harm. That obligation, however, is so abstract that it tells us little about exactly how much effort and sacrifice is required of us, especially where many people share responsibility for avoiding harm. I have an obligation not to harm others by polluting the environment, but it does not follow that I must stop driving my car at the cost of my job and the opportunities it makes possible for my family. That would be an unfair burden. These abstract difficulties multiply as we turn to the context of engineering practice which involves collective responsibility for technological products.

Engineers work as members of authority-structured teams which sometimes involve hundreds of other professionals who share responsibility for inherently risky technological projects. Engineers are not the only team-members who have responsibilities to create safe products. Their managers have exactly the same general responsibilities. In fact, they have greater accountability insofar as they are charged with the authority to make final decisions about projects. True, engineers have greater expertise in safety matters and hence have greater responsibilities to identify dangers and convey that information to management. But whatever justifications can be given for engineers to zealously protect public safety also apply to managers.

Dan Applegate and Roger Boisjoly acted responsibly in making unequivocal safety recommendations; their managers failed to act responsibly. Hence their moral dilemmas about whether to whistleblow arose because of unjustified decisions by their superiors. It is fair to ask engineers to pick up the moral slack for managers' irresponsible decisions—as long as we afford them legal protection to prevent their being harassed, fired, and blacklisted. Otherwise, we impose an unfair burden. Government and the general public share responsibility for safety in engineering. They set the rules that business plays by. It is hypocrisy for us to insist that engineers have an obligation to whistleblow to protect us, and then to fail to protect them when they act on the obligation.

[9]James, "Whistle Blowing: Its Moral Justification," pp. 334–335.

(iii) The ***Professional-Status Argument*** asserts that engineers have special responsibilities as professionals, specified in codes of ethics, which go beyond the general responsibilities incumbent on everyone to prevent and avoid harm, and which override all personal considerations. Most engineering codes hint at a whistleblowing obligation with wording similar to that of the code of the National Society of Professional Engineers (NSPE):

> Engineers shall at all times recognize that their primary obligation is to protect the safety, health, property and welfare of the public. If their professional judgment is over-ruled under circumstances where the safety, health, property or welfare of the public are endangered, they shall notify their employer or client and such other authority as may be appropriate.

The phrase "as may be appropriate" is ambiguous. Does it mean "when morally justified," or does it mean "as necessary in order to protect the public safety, health, and welfare"? The latter interpretation is the most common one, and it clearly implies whistleblowing in some situations, no matter what the personal cost.

I agree that the obligation to protect public safety is an essential professional obligation that deserves emphasis in engineers' work. It is not clear, however, that it is paramount in the technical philosophical sense of overriding all other professional obligations in all situations. In any case, I reject the general assumption that codified professional duties are all that are morally relevant in making whistleblowing decisions. It is quite true that professional considerations require setting aside personal interests in many situations. But it is also true that personal considerations have enormous and legitimate importance in professional life, such as in choosing careers and areas of specialization, choosing and changing jobs, and deciding how far to go in sacrificing family life in pursuing a job and a career.

Where does all this leave us on the issue of engineers' obligations? It is clear there is a minimum standard which engineers must meet. They have strong obligations not to break the law and not to approve projects which are immoral according to standard practice. They also have a *prima facie* obligation to whistleblow in certain situations. Just how strong the whistleblowing responsibility is, all things considered, remains unclear—as long as there are inadequate legal protections.

What is clear is that whistleblowing responsibilities must be understood contextually, weighed against personal rights and responsibilities, and assessed in light of the public's responsibilities to protect whistleblowers. We must look at each situation. Sometimes the penalties for whistleblowing may not be as great as is usually the case, perhaps because some protective laws have been passed, and sometimes family responsibilities and rights to pursue a career may not be seriously affected. But our all-things-considered judgments about whistleblowing are not a matter of a general absolute principle that always overrides every other consideration.

Yes, the public has a right to be warned by whistleblowers of dangers—assuming the public is willing to bear its responsibility for passing laws protecting whistleblowers. In order to play their role in respecting that right, engineers should have a legally-backed *right of conscience* to take responsible action in safety matters beyond the corporate walls.[10] As legal protections are increased, as has begun to happen during the past decade,[11] then the relative weight of personal life to professional duty changes. Engineers will be able to whistleblow more often without the kind of suffering to which they have been exposed, and thus the *prima facie* obligation to whistleblow will be less frequently overridden by personal responsibilities.

Character, Integrity, and Personal Ideals

Isn't there a danger that denying the existence of absolute, all-things-considered principles for whistleblowers will further discourage whistleblowing in the public interest? After all, even if we grant my claims about the moral relevance of personal rights and responsibilities, there remains the general tendency for self-interest to unduly bias moral decisions. Until adequate legal protection is secured, won't this contextual approach result in fewer whistleblowers who act from a sense of responsibility? I think not.

If all-things-considered judgments about whistleblowing are not a matter of general rule, they are still a matter of good moral judgment. Good judgment takes into account rules whenever they provide helpful guidance, but essentially it is a product of good character—a character defined by virtues. Character is a further area in which personal aspects of morality bear on engineering ethics, and in the space remaining I want to comment on it.

Virtues are those desirable traits that reveal themselves in all aspects of personality—in attitudes, emotions, desires, and conduct. They are not private merit badges. Instead, virtues are desirable ways of relating to other people, to communities, and to social practices such as engineering. Which virtues are most important for engineers to cultivate?

Here are some of the most significant virtues, sorted into three general categories.[12]

(1) Virtues of self-direction are those which enable us to guide our lives. They include the *intellectual virtues* which characterize technical expertise: mastery of one's discipline, ability to communicate, skills in reasoning, imagination, ability to discern dangers, a disposition to minimize risk, and humility (understood as a reasonable perspective on one's abilities). They also include *integrity virtues*, which promote coherence among one's attitudes, commitments, and conduct based on a core of moral concern. They include honesty, courage, conscientiousness, self-respect, and fidelity to promises and commitments—those in both personal and professional

[10] I defend this right in "Rights of Conscience Inside the Technological Corporation," *Conceptus-Studien, 4: Wissen and Gewissen* (Vienna: VWGO, 1986): 179–191.

[11] Alan F. Westin offers helpful suggestions about laws protecting whistleblowers in *Whistle-Blowing!* For a recent overview of the still fragmented and insufficient legal protection of whistleblowers see Rosemary Chalk, "Making the World Safe for Whistle-Blowers," *Technology Review* 91 (January 1988): 48–57; and James C. Petersen and Dan Farrell, *Whistleblowing: Ethical and Legal Issues in Expressing Dissent* (Dubuque, IA: Kendall/Hunt, 1986).

[12] Important discussions of the role of virtues in professional ethics include: John Kultgen, *Ethics and Professionalism* (Philadelphia: University of Pennsylvania Press, 1988); Albert Flores (ed.), *Professional Ideals* (Belmont, CA: Wadsworth, 1988); and Michael D. Bayles, *Professional Ethics*, 2d ed. (Belmont, CA: Wadsworth, 1989). John Kekes insightfully discusses the virtues of self-direction in *The Examined Life* (Lewisburg, PA: Bucknell University Press, 1988).

life. And wisdom is practical good judgment in making responsible decisions. This good moral judgment, grounded in the experience of concerned and accountable engineers, is essential in balancing the aspirations embedded in the next two sets of virtues.

(2) Team-work virtues include (a) loyalty: concern for the good of the organization for which one works; (b) collegiality: respect for one's colleagues and a commitment to work with them in shared projects; and (c) cooperativeness: the willingness to make reasonable compromises. Reasonable compromises can be integrity-preserving in that they enable us to meet our responsibilities to maintain relationships in circumstances where there is moral complexity and disagreement, factual uncertainty, and the need to maintain ongoing cooperative activities—exactly the circumstances of engineering practice. Unreasonable compromises are compromising in the pejorative sense: they betray our moral principles and violate our integrity. Only good judgment, not general rules, enables engineers to draw a reasonable line between these two types of compromise.

(3) Public-spirited virtues are those aimed at the good of others, both clients and the general public affected by one's work. *Justice virtues* concern fair play. One is respect for persons: the disposition to respect people's rights and autonomy, in particular, the rights not to be injured in ways one does not consent to.

Public-spiritedness can be shown in different degrees, as can all the virtues. This helps us understand the sense of responsibility to protect the public that often motivates whistleblowers. Just as professional ethics has tended to ignore the moral relevance of personal life to professional responsibilities, it has tended to think of professional responsibilities solely in terms of *role responsibilities*—those minimal obligations which all practitioners take on when they enter a given profession. While role responsibilities are sufficiently important to deserve this emphasis, they are not the whole of professional ethics. There are also *ideals* which evoke higher aspirations than the minimum responsibilities.[13] These ideals are important to understanding the committed conduct of whistleblowers.

Depth of commitment to the public good is a familiar theme in whistleblowers' accounts of their ordeals. The depth is manifested in how they connect their self-respect and personal integrity to their commitments to the good of others. Roger Boisjoly, for example, has said that if he had it all to do over again he would make the same decisions because otherwise he "couldn't live with any self-respect." Similarly, Frank Camps says he acted from a sense of personal integrity.

Boisjoly, Camps, and whistleblowers like them also report that they acted from a sense of responsibility. In my view, they probably acted beyond the minimum standard that all engineers are required to meet, given the absence of protective laws and the severity of the personal suffering they had to undergo. Does it follow that they are simply confused about how much was required of them? [The answer is no.] . . .

There is such a thing as voluntarily assuming a responsibility and doing so because of commitments to (valid) ideals, to a degree beyond what is required of everyone. Sometimes the commitment is shown in career choice and guided by religious ideals; think of Albert Schweitzer or Mother Teresa of Calcutta. Sometimes it is shown in professional life in an unusual degree of *pro bono publico* work. And sometimes it is shown in whistleblowing decisions.

According to this line of thought, whistleblowing done at enormous personal cost, motivated by moral concern for the public good, and exercising good moral judgment is both (a) supererogatory—beyond the general call of duty incumbent on everyone, and (b) appropriately motivated by a sense of responsibility. Such whistleblowers act from a sense that they *must* do what they are doing.[14] Failure to act would constitute a betrayal of the ideal to which they are committed, and also a betrayal of their integrity as a person committed to that ideal.

Here, then, is a further way in which personal life is relevant to professional life. Earlier I drew

[13]On the distinction between moral rules and ideals see Bernard Gert, *Morality* (New York: Oxford University Press, 1988), pp. 160–178.

[14]Harry Frankfurt insightfully discusses this felt "must" as a sign of deep caring and commitment in *The Importance of What We Care About* (New York: Cambridge University Press, 1988), pp. 86–88.

attention to the importance of personal rights and responsibilities, and to the unfair personal burdens when others involved in collective enterprises fail to meet their responsibilities. Equally important, we need to appreciate the role of personal integrity grounded in supererogatory commitments to ideals. The topic of being able to live with oneself should not be dismissed as a vagary of individual psychology. It concerns the ideals to which we commit ourselves, beyond the minimum standard incumbent on everyone. This appreciation of personal integrity and commitments to ideals is compatible with a primary emphasis on laws that make it possible for professionals to serve the public good without having to make heroic self-sacrifices.

Discussion Questions

1. Martin outlines three approaches to whistleblowing. Explain how each one works. Use moral theory to explain how one might attempt to justify each of the three.
2. What are the problems Martin finds with each of these three approaches? Is he justified in all of his criticisms?
3. Martin summarizes three arguments supporting the claim that engineers are sometimes required to hold their own interest to be insignificant when compared to the public welfare. What are these arguments and what problems does he find with each one?
4. Why does Martin discuss good moral judgment? What, exactly, is its role in his views of whistleblowing?

Can Engineers Hold Public Interests Paramount?

TAFT H. BROOME, JR.

I. Introduction

Perhaps the most pervasive issue plaguing every attempt engineers have made to develop a code of ethics for their profession is the continuing controversy over rules stipulating something like "the engineer shall hold paramount the health, safety and welfare of the public in the performance of his professional duties."[1] Most engineering professional societies which have codes of ethics have adopted such rules—hereinafter referred to as "public paramountcy" rules. The American Association of Engineering Societies (AAES), a federation of thirteen major engineering professional societies, is one example. The Institute of Electrical and Electronics Engineers (IEEE), largest of the engineering professional societies, is a noteworthy exception.

Underlying the public paramountcy issue is a sentiment which spans the memberships of the various engineering professional societies, and is apparently shared by most engineers. This sentiment asserts that engineers *cannot assure* the health and welfare of the public because risk-free

[1]This language was first introduced by the Engineers' Council for Professional Development (ECPD, renamed Accreditation Board for Engineering and Technology, i.e., ABET) in 1947 (see "Code of Ethics of Engineers," ECPD, Oct. 5, 1977).

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engineering often cannot be achieved. Thus, a problem is posed for the incorporation of a public paramountcy rule into codes of ethics since any rule stipulating what one *should* do has no logical status if one *cannot* do it.

The purpose of this paper is to consider the problem of whether public paramountcy rules are consistent with correct conceptions of the fundamental nature of engineering. I will argue that (a) while public paramountcy rules are consistent with conventional applied science conceptions of engineering, these concepts are incorrect; and that (b) ordinary means of public paramountcy are not consistent with the new correct praxiology conception of engineering. Instead of suggesting that public paramountcy rules be repealed from engineering codes of ethics, qualifications for ordinary meanings of public paramountcy are offered that provide consistency between such rules and the correct conception of engineering.

II. The Nature of the Problem

Unlike many physicians and lawyers, engineers are typically employees in large bureaucracies. Within these bureaucracies one can distinguish two types of engineers: the "line" engineer, whose workload is principally of an engineering nature, and the engineer-manager, whose responsibilities are mainly managerial. Since most engineer-managers evolve from line engineers, a chronological boundary can be drawn between the collectivity of the younger and that of the older engineers that roughly separate the line from the engineer-manager types.

Line engineers can look forward to substantial increases in salary as their evolution across this boundary takes place. The further up the managerial ladder the engineer goes, the less he or she can expect to return to engineering work of the line type since one's technical skills tend to diminish rapidly when not used, and one's efforts to gain new skills are often thwarted by the intensity of the bureaucratic life. Thus, older engineers often have fewer employment options than do line engineers and, therefore, have stronger ties of dependency to their employers. Pressures to conform to bureaucratic demands for loyalty are high in work environments where employees can be fired and blackballed, and alternative employment opportunities are few. Such factors undoubtedly contribute to differences in attitudes characteristic of the line and managerial types about the kinds of relationships that should exist between their profession and the public, and between their profession and their employers.

Layton[2] refers to the younger engineers as the collectivity which, historically, has regarded the promotion of the public interest or the general health and welfare to be a professional responsibility. Younger engineers tend to insist that whenever public interests conflict with business interests, the public welfare should be the paramount concern. Layton refers to the older engineers as the collectivity which contains the politically and economically potent managerial class who, unlike the younger engineers, consider the business interests of engineering to be compatible or not to conflict with the public good. When issues arise that pit profit interests against the public welfare, battle lines within the profession often correspond to a division between youth and age—between line engineer and engineer-manager—between the politically weak and politically strong. Thus, younger engineers have in the past sought to strengthen their position by attempting to unite the profession (across disciplines). Such attempts have repeatedly failed, but their histories fit into a now familiar pattern.

The AAES, a new unity organization, was formed in 1980 and now consists of over thirteen member societies. From its structure one might argue that the AAES was formed to represent a single voice for the engineering profession in the U.S. political arena—possibly for the purpose of advancing business interests. However, there appears to be little reason to suspect that the AAES was formed to meet any solidarity aims of either older or younger engineers. Indeed, the fact that younger engineers are not visible in this debate is a matter of curiosity. Perhaps because engineering professional societies are dominated by the older engineers, this debate has not aroused the political passions of the younger engineers. Instead, the issues being debated are those of concern to the managerial class.

[2]E. T. Layton, *The Revolt of the Engineers* (Cleveland, OH: Case Western Reserve University Press, 1971).

Contemporary engineering managers are no less concerned that the interests of employers or clients be served than has been the case in the past. However, the social context in which these concerns are manifest creates more complex and dynamic public-versus-employer conflicts. Americans more often use the word "public" in an expanded sense that transcends national boundaries so that consideration can be given to conflicts between, on the one hand, world health and welfare interests and, on the other hand, both (a) national security interests of business and military employers in nuclear and space-based or SDI-type defense systems; and (b) business interests of multinational corporate employers or clients in apartheid and in the technological affairs of developing countries, and other interests. Owing to the growing credibility of Gian theory, the notion of "public health and welfare" may soon give way to "stability and integrity of the ecosystem" allowing moral status to be given to nonhuman nature. Thus, these expanded interests on the public side of our debate are pitted against the business side which is grappling with global financial austerity, international competition and the dynamics of technological innovation.

One can observe that the managerial class of engineers uses a strategy to deal with these difficulties that involves (a) the claim that engineering is a science so as to gain the confidence and support of the public for engineering business enterprises; and (b) the claim that engineering is not a science and is laden with risk so as to maintain public confidence in, and support for engineers in the wake of technological failures. The problem addressed in this paper is to resolve these two contradictory claims and formulate a meaning for public paramountcy that is consistent with a correct view of engineering.

III. The Conventional Applied Science View of Engineering: The Claim to "Know" Is Good for Business

Until recently, virtually every definition of the term "engineering" has included something like "the application of science to practical or societal problems." On this view, engineering research is scientific and professional engineers are "applied" scientists (who use science to solve practical problems) as distinct from "pure" scientists (who use science to create more science). Engineers as scientists can thus enjoy the faith Americans have in the scientific method, and can even claim to "know" why and how technology works. When supported by credentials taken from the culture of engineering (e.g., formal education, licensure, experience, membership in professional societies, etc.) such claims enable engineers to narrow the field of competition and gain public sanction of business interests. However, although most engineers probably regard the notion of engineering as an applied science to be appealing, these same engineers share the view that the functioning of engineering products often cannot be deduced from scientific principles alone and that the concept of "risk-free" engineering is a myth.

The inconsistency of believing, on the one hand, that engineering is a science and, on the other hand, that engineering neither helps engineers to "know" exactly how technology will respond to these conditions, gives evidence of confusion about the nature of engineering and provides a clue to the possibility of error in the applied science view.

The error in the applied science conception is that engineering methodology consists not of scientific principles alone, but of scientific principles together with a constellation of non-scientific heuristics. Moreover, the observation that engineering practices are often established and used successfully well in advance of their incorporation within scientific theory suggests that the same arguments used to define engineering as applied science could be used to (incorrectly) define science as some sort of theoretical engineering. Which conception of engineering is correct?

IV. The New Praxiology View of Engineering: A Correct Conception

The Greek term "praxis" has an ordinary meaning that roughly corresponds to the ways in which we now commonly speak of "action" or "doing," and it is frequently translated into English as "practice." Whereas "practice" connotes for some people mundane activities that is not motivated by theoretical considerations, "praxis" takes on a quasitechnical meaning derived from Aristotle. The twentieth century Polish philosopher Kortabinsky,[3] apparently motivated by the Aristotelian usage, introduced the term "praxiology" to mean the theory of efficient action, and more recently the term has been employed, in a slightly different spelling, by Scandinavian philosophers in their contribution to the analytic theory of action.[4] In my modified usage, praxiology is juxtaposed to epistemology, and functions as the basis for a correct understanding of engineering (as a scholarly discipline) in the same way that epistemology does in the philosophy of science.

On the one hand, epistemology may be characterized as the branch of philosophy that analyzes the nature of knowledge—and contains theories that aim to answer questions such as "What is the nature of knowledge?" and "How is knowledge obtained?" On the other hand, I have defined praxiology as the branch of philosophy that analyzes the nature of change—and contains theories that aim to answer questions such as "What is the nature of the proposed change?" and "How are purposeful changes effected?"

The argument for praxiology as deserving of philosophical attention is based on the natural inclination of people to acknowledge the "engineering" imperative to improve the human condition before all the facts are in that could enable one to predict with certainty or (sometimes) even with regularity the outcome of the change. Moreover, it is natural for people to regard the human condition as one that is complex and important enough to warrant application of their minds to develop theoretical bases for the attempts made to fulfill the engineering imperative.

Since physical science can be defined as a kind of epistemology, i.e., one that consists of theories of knowledge about physical nature, I would define engineering as a kind of praxiology, one that consists of theories about changing physical nature. To illustrate these conceptions, one can consider two different ways in which scientists and engineers might typically view some dispositional property of physical objects.

An object may be said to possess the dispositional property "fragile" if one can observe the object to break when struck in a particular way. The assumption here is that the striking procedure and the method for observing the breaking of an object are well-defined and together constitute a test. If no member of a particular class of like objects has ever been tested, then, the scientist would not claim to "know" whether the object is fragile. However, the engineer, being concerned with making conservative judgments in the absence of scientific facts, would conceivably *assign* the property "fragile" to the object until it is tested, then acknowledge the appropriate property of the object following the test. If the object were tested, then both the scientist and engineer would extend the results of the test to all like objects. However, if two identical objects were similarly tested and different results were observed, then the scientist would abandon the test as a means of obtaining knowledge about such objects, whereas the engineer would not necessarily do so if it exhibited "consistent enough" results. What scientists admit as consistent enough results are those that are controllably predictive. What engineers admit as consistent enough results are those that can be used to obtain acceptable risks.

The literature abounds with conceptions of how these risks are or ought to be assessed, and with the various human populations (e.g., employers, clients, end-users, etc.) actually targeted or who ought to be targeted by engineers for gaining acceptance of these risks. The point being made here is that neither universal acceptability of these risks, nor the acceptance of all affected rational persons is sought. Indeed, standards for acceptability of risks and, thus, standards for consistency of engineering test results, are components of the lore of engineering which is established by the profession and maintained by force of law, habit, and the suppression of divergent views during the engineering educational process.

This illustration indicates how scientific and engineering theories are oriented differently to the physical world. The error in the applied science view is that engineering methodology consists not of scientific principles alone, but a blend of these

[3]The term "praxiology" apparently originated in T. Kortabinsky (trans. O. Wajtasiewicz), *Praxiology* (Oxford: Pergamon Press, 1965), p. 1. Kortabinsky defines praxiology as the theory of efficient action. A somewhat different definition of the term is presented in this paper.

[4]G. Skirbekk, ed., *Praxiology: An Anthology* (New York: Columbia University Press, 1984).

principles with a lore for the purpose of "changing" physical nature at the expense of—at best—attaining "acceptable" risks. "Acceptable to whom?" and "By what method of risk assessment?" are questions that are dealt with in engineering lore which contains a variety of Koen's "engineering heuristics,"[5] together with trial-and-error case histories, organizational means for establishing procedural conventions, institution[s], etc., which are handed down to engineers from their predecessors. Thus, engineers can only seldom claim on rational grounds to "know" how complex technologies will affect people.

The praxiology view supports the claim that engineering is not a science and is laden with risk. Thus, part of our problem is resolved. What remains is to formulate a meaning for public paramountcy that is consistent with praxiology.

V. Meanings of Public Paramountcy

One inference from the idea that engineering is a science is that engineering judgment deserves the faith that people put in scientific judgments. This is not to say that people never observe scientific judgments to be in error. When new facts are discovered that disprove a scientific theory, scientists are known to make public disavowals of prior judgments based on the theory, but to insist that they were correct to *claim* (at the time) that those judgments were scientifically sound. However, engineering judgments can be valued as "good" independently of their scientific soundness. Thus, a person who assumes that engineering is a science may be misled into assuming that engineering judgments are scientifically sound and, thereby, be misled by his assessment of the possibility of risk being associated with engineering work. Furthermore, a person who assumes that engineering is a science could reasonably interpret a public paramountcy rule in an engineering code of ethics to mean that the engineer should not, by forgoing scientific analyses of his work, introduce public risk into engineering work for reasons of expediency, cost, and so forth. Engineers, however, know that scientific analyses of engineering work are typically forgone, and not just because of pressures from an employer or client.

Since applied science views of engineering have been articulated in the literature, and since the new praxiology view is yet obscure to the public eye, the above inference about the meaning of public paramountcy will be considered an "ordinary" meaning. Other ordinary meanings can be identified. The point is that there are ordinary meanings that are not consistent with the correct praxiology view of engineering. How, then, can public paramountcy rules in engineering codes of ethics be qualified so as to make them consistent with praxiology?

Since the praxiology view of engineering suggests that risk is a part of the nature of engineering, this view is also consistent with the "engineering experiment" view[6] which observes engineering works to be experiments involving human subjects (i.e., the public). According to Martin and Schinzinger, originators of this view, moral relationships between engineers and the public should be of the informed consent variety. Thus, a code of ethics should not be contradictory to the notions that (a) affected parties should be aware of the risks associated with engineering works; and that (b) in some reasonable measure, their consent to participate in these works should be obtained. An example of a qualifier for public paramountcy rules that is consistent with these notions is as follows:

> The engineer shall not claim that engineering necessarily assures good public health and Welfare. Instead, he shall advise the public of the risks associated with his work and seek to obtain public acceptance of these risks.

In stipulating that engineering does not necessarily guarantee public health, this sort of qualifier eliminates scientific assurances from the scope of ordinary meanings that can reasonably be attached to public paramountcy. Moreover, this qualifier is consistent with the various whistle-blowing provisions which stipulate that the engineer should make the public aware of dangers to the general welfare. This qualifier also clarifies what the engineer can and shall hold paramount.

[5] B. V. Koen, "Towards a Definition of the Engineering Method," *Engineering Education*, 75, no. 3 (December, 1984), pp. 150–155.

[6] M. Martin, and R. Schinzinger, *Ethics in Engineering* (New York: McGrawHill, 1983).

Instead of holding *assurance of* public health, safety and welfare to be paramount, qualified public paramountcy thereby means that the engineer shall hold *acceptability of risk* to public health, and so forth, to be paramount. Questions like "Acceptable to whom?" "What are appropriate grounds for acceptance?" and "What are reasonable methods of assessing risk?" are answered in the contexts of public law and methodological precedence as existing in the lore of engineering. Thus, the engineer *can* comply with qualified public paramountcy rules.

Discussion Questions

1. Why does Taft Broome argue that the conventional science conceptions of engineering are incorrect? How does the debate of public paramountcy fit into this argument?
2. What are some of the problems with engineering codes of ethics that require engineers to hold public welfare "paramount"? Why is the notion of public paramountcy inconsistent with the new conception of engineering, according to Broome? To what extent do you agree with this claim?
3. How does Broome make the notion of public paramountcy consistent with the new view of engineering?
4. How could Broome's conclusion be used to help engineering firms make ethically sound decisions about just how safe their products should be?
5. Are the responsibilities imposed by Broome's theory "ordinary" in the sense described by Welch (Chapter 2) or are they more consistent with Smith's "separatist" account (also from Chapter 2)?

Trade Secrets and Patents in Engineering: Ethical Issues Concerning Professional Information

EUGENE SCHLOSSBERGER

ADVANCING HUMAN PROGRESS, a key value of the engineering profession,[1] usually requires the free and open exchange of ideas and knowledge. Yet companies cannot afford research and development if the knowledge they acquire at great cost is freely appropriated by their competitors. When Company M simply appropriates Company N's costly research, Company M has lower research costs than Company N, and so, other things being equal, can produce the same product or service more cheaply. So, in a market economy, the goal of advancing human progress demands a trade-off between sharing knowledge and protecting knowledge. An ethical approach to patents and trade secrets maintains the right balance between those two goals. Engineers must find that balance when addressing three ethical questions about the use of professional informa-

[1]See Schlossberger, Eugene, *The Ethical Engineer* (Philadelphia: Temple University Press, 1993), which contains a more detailed discussion of some of these issues.

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Some ideas in this article are also found in Eugene Schlossberger, The Ethical Engineer *(Philadelphia: Temple University Press, 1993). Printed with kind permission of the author.*

tion: May an engineer use professional information obtained while working for another employer or client? When is it ethical to reveal trade secrets? Is it wrong to "get around" patent laws by making minor changes in a patented process or device?

Types of Professional Information

Professional information in engineering falls into four categories: patented information, trade secrets, tricks of the trade, and general knowledge.

General knowledge is information that is generally available. Information found in textbooks, journal articles, university courses, seminars, and conferences [is a form] of general knowledge. The two defining characteristics of general knowledge is that the information is publicly available and its use is not legally restricted.

Tricks of the trade are harder to define. They are shortcuts, problem-solving strategies, unofficial solutions to common types of problems, ways of thinking, approaches, and other nonpatentable information and ideas one learns by working and by being around others who have had considerable experience. Tricks of the trade include what one learns through an apprenticeship, from a mentor, or through working together with other experienced professionals. Tricks of the trade are insider information, information not publicly available but learned from one's own experiences as an engineer or by being privy to the experiences of another engineer.

Trade secrets are either proprietary information or business secrets. Business secrets include specific company plans or business data not available to the public. Proprietary information includes specific secret processes, ingredients, etc.

Patented information is publicly available information whose use is legally restricted.

Revealing Information

There are several reasons why engineers changing employers are obligated to respect the trade secrets of their previous employers.

Engineering is a co-operative venture. In addition to workbenching (leaving plans or models on the workbench for everyone to look at and make suggestions), engineers often talk about aspects of their projects with other engineers. The "workbench mentality" is an important part of the culture of engineering that benefits engineers, their employers, and the society at large. Engineers benefit because the workbench mentality gives them a sense of being part of a community dedicated to important goals, rather than hired hands coming in to do a task. It stimulates creativity and excitement, challenging engineers to be the best engineers they can be. Employers enjoy greater productivity, both through improvements due to other engineers' input and through increased employee motivation and job satisfaction. The public benefits because the result of this cooperation and brainstorming is a better, cheaper, and/or safer product. In short, engineering as a field is justifiably committed to the workbenching mentality. But, obviously, employers cannot permit, much less encourage, a workbenching mentality if employees who see the company's advances and discoveries might take them to a competitor. A necessary condition for a workbenching mentality is a firm understanding that employees who become privy to a company's secrets will not use those secrets for (or reveal them to) a competitor. In a sense, then, engineers, by working as engineers, make an explicit or implicit promise to respect trade secrets. Put another way, the duty to respect trade secrets is a justifiable institutional duty of engineering, and hence anyone who chooses to become an engineer has a duty to respect trade secrets.

A second argument concerns the duty of loyalty. Engineers are professionals, and their contract with the firm they work for calls for a semi-fiduciary relationship: in exchange for their salaries and benefits, engineers are expected not simply to perform whatever tasks they are assigned, but to employ their talents and abilities for the benefit of the company. Engineers receive various benefits from their status as professionals, including higher pay and greater respect. To accept these benefits of their semi-fiduciary status without fulfilling the obligations of that role is dishonest and unfair. So engineers have fiduciary duties of loyalty to their companies. When an engineer's employment at Company N ends on March 9, the scope of her duties of loyalty to Company N stops at March 9—she has no loyalty to Company N concerning matters that arise after

March 9. However, her duties of loyalty do not end on March 9: she continues to have duties of loyalty to Company N concerning her work for the company before March 9. After all, fiduciary duties are duties of trust, and trust is ill placed if the information or other advantages obtained during the period of trust may be used against one after the fiduciary relationship concludes. You would not, for example, confide in your attorney if he felt free, after the trial, to broadcast what you told him. So trade secrets continue to be protected by the duty of loyalty even after employment ends.

Finally, respecting Company N's trade secrets when the engineer moves to Company M, by forcing the engineer to try novel approaches to problems, has the potential to advance human progress.

On the other hand, there are good reasons why general knowledge an engineer acquired during employment should be considered the property of the engineer. After all, the employer has no special claim on that information itself—it is public information. The employer might have paid the cost of the engineer's learning that information, but one cannot gain the right to restrict someone's use of widely available information simply by being the one to tell her about it or by paying for someone else to tell her. If one could, one might eventually gain a virtual monopoly on the use of information in a common reference book simply by mailing the book to enough engineering students. Thus it is widely acknowledged that engineers may make use of any general knowledge they might have when changing employers, even if that general knowledge was acquired on the job or as a result of courses or conferences paid for by the employer.

Tricks of the trade present the most difficulty, as it is sometimes difficult to distinguish between tricks of the trade and trade secrets or between tricks of the trade and general knowledge. As noted in *The Ethical Engineer,* it is absurd to expect an engineer to try on Company M's time a solution that she has already seen will not work when working at Company N. Doing so ill serves the engineer's loyalty to Company N and to the goal of advancing human progress.

In sum, the general rule in engineering, is that general knowledge and tricks of the trade go with the engineer while trade secrets stay with the employer.[2]

The duty to respect trade secrets, like most duties, has limits and is sometimes overridden by more urgent duties. Trade secrets that are themselves improper or immoral are not covered by the duty to respect trade secrets. That P Company's secret process illegally infringes a patent is a trade secret, but not one that engineers have a special duty to protect: the duty to respect that trade secret is *voided*. (Of course, the engineer retains her general duty of loyalty to the company, a duty that might affect how and to whom the engineer reveals the information.) In other cases, the duty to respect trade secrets may be ***overridden***. An engineer morally obligated to blow the whistle on a safety issue might need to reveal trade secrets in the process of explaining and documenting the danger. Because the trade secrets themselves are not morally tainted, the duty to preserve trade secrets remains, but must bow to the more pressing duty to alert the public or proper officials about a severe safety hazard. Overridden duties are nonetheless duties and can have important consequences. The duty to respect trade secrets requires at least four things of an engineer blowing the whistle:

1) The engineer should make every effort to avoid having to blow the whistle, for example by exhausting all in-house remedies.
2) The engineer should make every effort to reveal as few or as little about trade secrets as possible in the process of blowing the whistle.
3) The engineer should make every effort to restrict access to the trade secret (reveal it to as few sources as necessary).
4) The engineer should make every effort to inform the company beforehand about trade secrets that must be revealed.[3]

[2]Some businesses try to restrict use of tricks of the trade in direct competition, for example, by asking employees to sign employment contracts guaranteeing that they will not compete with the employer for so many years after leaving or within a certain radius. Such contracts are unusual in engineering.

[3]Philosophers sometimes talk about *prima facie* duties and final duties. We all have a prima facie duty to keep our

Respecting Patents

Engineers are generally required to keep to the letter of patent and copyright laws. To what extent is it unethical to make modifications in a patented process that do not violate the law but amount to "stealing" the idea? Engineers must find a balance between being fair to the patent-holder on the one hand and, on the other, loyalty to their employers' interests and to the goal of advancing human progress. There is no formula for finding such a balance, but *The Ethical Engineer* lists four relevant questions:

1) To what extent has the patent-holder had the opportunity to benefit from the patent?

2) Is the modification a genuine improvement on the original or just a device for skirting patent laws?

3) How significant is the modification? How big a change is it?

4) Is there any doubt about whether using the modified process is legally permissible?

promises, but sometimes our final duty is to break a promise, such as when I promise you I will attend your dinner but must break that promise in order to rescue my son from a burning building. This example shows that the distinction is at best misleading, because it ignores the distinction between voided and overridden duties. If I discover that a promise I made was obtained by fraud, I nonetheless made a promise, and as a result I may have some duties to innocent third parties who acted in reliance on the promise, but the duty to keep the promise is voided. By contrast, the duty to keep my promise to attend your dinner is overridden by the duty to rescue my son. Both are *prima facie* duties, but the moral situation, the nature of the moral pull exerted by the duty, is quite different in the two cases.

Conclusion

As with most human activities, an engineer's revealing or using information falls into three categories: cases that are clearly permissible, cases that are clearly impermissible, and difficult cases about which there is legitimate doubt and disagreement. The factors discussed above help an engineer in identifying which choices fall into the first two categories and in coming to an ethically defensible view about difficult cases. Ethics, as Aristotle says, is not an exact science, but that does not mean it yields no results. Some choices are clearly wrong. Some choices are clearly permissible. Some views about the remaining choices are reasonable and others are not. Engineers must make a good faith effort to weigh all the relevant ethical factors and, to the best of their abilities, make ethically defensible choices.

Discussion Questions

1. What is professional information? What are the guidelines suggested by Schlossberger for determining whether an engineer may use professional information obtained while working for another employer or client?
2. According to Schlossberger, is it ever ethical to reveal trade secrets? What about general knowledge or tricks of the trade? Do you agree with his claims?
3. Schlossberger suggests that the duty to respect trade secrets has limits, and is overridden when various conditions are met. What moral theory (or theories) might justify his analysis of the limits of the duty to respect trade secrets? How might someone disagree with his analysis?
4. To what extent do you think it is unethical to "get around" patent laws by making minor changes in a patented process or device?

Optimization, Option Disclosure, and Problem Redefinition: Derivative Moral Obligations of Engineers and the Case of the Composite-Material Bicycle

ROBERT E. MCGINN[1]

I. Introduction

In April 1995, I conducted an informal survey of then current Stanford engineering students and practicing engineers. One of my objectives was to get a sense of the expectations and experiences of both groups regarding the prevalence and diversity of ethical issues in engineering. To that end, one survey questionnaire item directed at practicing engineers asked, "Have you ever been faced with an ethical issue in the course of your engineering practice?" Respondents answering in the affirmative were invited to "please describe briefly what kind of issue it was." The unexceptional nature of this question and request notwithstanding, one practicing engineer was moved to compose and attach to his completed questionnaire an ethically rich, autobiographical case study. After relating this case, I will analyze the ethical issues it raises and draw several conclusions of a more general nature. To preserve confidentiality and increase candor, the names of the engineer-respondent and the other *dramatis personae* of the case, individual and corporate, have been altered.

II. Narrative

In the 1980s, bicycle journalists and corporate marketing departments campaigned for the development of strong, lightweight bicycles made of new, exotic, composite materials. Responding to this market pull, in 1989, Zephyr, a leading U.S. bicycle manufacturer, contracted for consulting services with an independent engineer, Smith, who claimed he had a workable method of designing and manufacturing composite-material bicycle frames.

When Smith was unable on his own to convince Zephyr of the workability of his approach, he engaged the services of my engineer-respondent, Brown, as a secondary consultant. Brown was engaged by Smith to "validate his methodology and technical approach,"[2] i.e., to confirm the workability of his plan for designing and manufacturing such bicycle frames. To promote his ideas, Smith subsequently organized a meeting among himself, Brown, and Zephyr's technical staff, whose members "knew little of composite structures" other than that, at the behest of the marketing division, "they wanted one in their product line." During Smith's presentation at the meeting, it became "quite obvious" to Brown that the proposed solution "created far more new problems than it attempted to solve." At one point in the meeting Smith asked Brown to "validate or endorse his structural concept," one which

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[2]Unreferenced quotations attributed to "Brown" in the text are drawn from the engineer-respondent's original written case study of April 1995. Additional quotations are drawn from three sources: remarks Brown made about this case at a May 1995 session of the above mentioned class, a May 1997 written critique Brown authored of a draft of the present essay, and remarks he made about this case at a May 1997 session of the same class. Quotations from these three sources are referenced (C95), (W97), and (C97) respectively.

Robert E. McGinn is Professor of Management Science and Engineering, Stanford University. *"Optimization, Option Disclosure, and Problem Redefinition: Derivative Moral Obligations of Engineers and the Case of the Composite-Material Bicycle,"* Professional Ethics 6 (1997), pp. 5–25. *Reprinted with kind permission of the author.*

"appeared workable by surface cosmetic and general conceptual standards, but did not have the underlying reinforcement fibers oriented to react to any of the critical load conditions this bicycle frame would see in use." In response, Brown "suggest[ed]" that he "apparently did not have the same insight and awareness of the problem as [Smith] and that [Smith's] understanding of the dynamics and intricacies of his concept surpassed his [Brown's] own." Brown "offered to refrain from commenting" until he "understood the process as well as its author."

Later in the meeting, Jones, the bicycle manufacturer's director of R & D, asked Brown "point blank" whether or not he thought Smith's was a workable approach. Brown answered that his "direct relationship" to Zephyr was only through Smith and that Brown's company[3] "would work with [Smith] to address issues which were important to the client's [Zephyr's] requirements."

The limitations of Smith's design and manufacturing concept became clearer to Zephyr as time passed. Eventually a representative of the company approached Brown without Smith's knowledge and confided that Zephyr wished to "begin a direct relationship" with Brown's company and "bypass" Smith altogether. Brown's reaction was to "simply state" that he would "continue to provide our services to [Smith] as we had agreed so long as that relationship existed with the client [Zephyr]; and that if ever that relationship should terminate equitably and the consultant [Smith] be compensated for bringing our company to the problem, we would then[,] with [Smith's] knowledge and consent[,] negotiate a direct contract with the bicycle company for the services sought." Eventually, Zephyr terminated its relationship with Smith. When Smith informed Brown that he was now free to begin a direct relationship with the bicycle company, Brown negotiated a new agreement with Zephyr. The result was "a $720,000 drafted contract that included royalties on each composite bicycle sold. . . . This was a very good deal for us, and as it turned out for the client as well."

After developing "a workable manufacturing plan for composite bicycles," but prior to deciding on a composite frame design, Brown felt it was important to see if the strength and stiffness of the *existing* 4.5 lb. production frame could be duplicated at a lighter weight. He asked Jones if he would agree to some finite-element computer runs aimed at optimizing the structure of the existing metal frame. Jones told Brown "in no uncertain terms, 'Do not do that!'" Since, however, Brown believed that doing so was "a vitally important step," he decided to optimize the structure at his own company's expense. What he determined was that the weight of the existing aluminum frame could be reduced with no loss of stiffness or strength from 4.5 to 3.1 pounds, within 2 ounces of the target weight of the projected composite-material frame.

With over $300,000 of the contract's $720,000 still unspent, Brown called Edwards, the president of Zephyr, and informed him that "'the cost to reduce the weight of his existing aluminum frame to 3.1 pounds was going to be about $6.35 per bicycle with no additional investment in facilities or personnel[,] compared to building a new facility, hiring and training a second production staff at an initial cost of $2.6 million[,] and a unit cost of $97.00.'" Edwards decided that "his marketing staff's insistence on having a carbon-fiber bicycle frame had more to do with incorporating the 'buzz-word technology *du jour*' than [with] relying on fundamental applied engineering to achieve the desired weight reduction deemed necessary to maintain market share." He therefore asked Brown to complete any task in progress and "bring the composite bicycle program to a close." The improved aluminum-frame bicycle was a successful part of Zephyr's product line from 1992 through 1996.

Edwards' decision to terminate the composite bicycle program "meant the loss of the remaining $300,000 on the contract" and that Brown's company's "was going [to] have a lot of unbillable time for a few months." It also saved Zephyr "a great deal of money!" To Brown, it also demonstrated that while "ethics have a price, . . . integrity has a reward." For, he revealed, "[t]he referral business from this experience has returned the lost revenue several times over." However, according to Brown, "money itself is not the best reward.

[3]Brown is owner and CEO of his own small consulting engineering firm which provides "engineering design and manufacturing services to people who are potential users of fiber-reinforced composites." (C95)

That comes from within and if you understand that, you probably have good ethics anyway. If you don't understand that, you probably didn't understand [the] choices made in this case history either!"

III. *Analysis of Ethical Issues*

Ethical issues are raised by the actions of various parties in this case, including Jones and perhaps Smith. In what follows, however, we shall focus our discussion on ethical issues raised by actions of Brown, or by actions of others that targeted Brown. Noteworthy ethical issues reared their heads at five junctures in this case: (1) when Smith asked Brown to endorse his method and approach at the meeting with Zephyr's technical staff; (2) when Jones asked Brown at the meeting whether he thought Smith's design and manufacturing concept was workable; (3) when Zephyr sought to bypass Smith and proposed to begin a direct relationship with Brown and his company; (4) when Brown was instructed by Jones not to optimize the structure of the existing metal frame; and, finally, (5) when Brown determined that an aluminum-frame bike could be designed that was as strong and almost as light as the desired composite-material bicycle. Let us look individually at each of these episodes.

EPISODE 1. SMITH ASKS BROWN TO ENDORSE HIS PLAN

When, at the meeting with Zephyr's technical staff, Smith asked Brown to "validate his [Smith's] methodology and technical approach," Brown felt himself embroiled in what he termed a "multifaceted . . . ethical quandary." On the one hand, since he had been introduced to Zephyr as an invitee of Smith, Brown felt "ethically bound not to undermine [Smith's] business with this client." On the other hand, since he also felt "bound to contribute both experience and technical expertise with integrity to my company and its reputation," Brown felt he "could not endorse the technically flawed program which was the subject of the meeting" without harming his own company and its employees. As noted earlier, his response was "to suggest that I apparently did not have the same insight and awareness of the problem as the consultant and that his understanding of the dynamics and intricacies of his concept surpassed my own. I offered to refrain from commenting until I understood the process as well as its author."

Brown's conduct was for the most part laudable, even, as we shall see below, exemplary. However, two aspects of his behavior in this first episode merit examination. First, as the above quote indicates, in his response to Smith's endorsement request at the meeting Brown dissembled and prevaricated. One reason he did so was because he adhered to a "simple business ethic." Under it, he believed himself "ethically bound" not to do anything that would undermine Smith's reputation with *his* client, Zephyr. Brown seems to have regarded that obligation as *absolutely* rather than *prima facie* binding. He realized that acceptance of Smith's approach "could cost the bicycle company many hundreds of thousands of dollars before they understood its weaknesses." That he feigned ignorance and was evasive even under that realization suggests that he felt the obligation not to undermine his client's was categorical.

But however he construed his "simple business ethic," Brown was not obliged to refrain from critical comments on Smith's method and approach by the "Code of Ethics for Engineers" of the National Society for Professional Engineers (NSPE).[4] While this code does state that engineers "shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers, nor untruthfully criticize other engineers' work" (Section III.8), it does not hold that engineers are obliged not to criticize their professional colleagues, only that such criticism as is made of their work by fellow engineers be truthful, nonmalicious, and not intended to injure. The ethic embodied in the NSPE code of ethics appears, in this instance at least, to be more nuanced and conditional than Brown's seemingly categorical "simple business ethic."[5]

[4]NSPE Publication Number 1102, January 1990.

[5]It turns out that Brown regards the principle of not doing anything to undermine a client's reputation with a third party as strongly presumptively rather than categorically valid. Questioned in 1997 about his seemingly categorical position he specified a strong preference for simply withdrawing from any project he deemed seriously and

If Zephyr had not eventually come to recognize the flaws in Smith's plan and had proceeded on the basis of that proposal, the company might not only have wasted much money but have reached a point at which it was on the verge of manufacturing and distributing structurally flawed bicycles. Whether Brown's adherence to his "simple business ethic" would have impelled him to continue to dissemble or be evasive if Zephyr was poised to make a decision that could have resulted in the delivery of a product that might jeopardize its users' physical safety is in principle unknowable. Fortunately, Brown's initial lack of candor was sufficiently upstream in the product development process that it did not contribute to creating an unreasonable risk of unjustifiable harm to members of the public.[6] However, his choice to remain publicly noncommittal, even though Zephyr stood to lose a lot of money investigating ideas of Smith that Brown knew to be structurally flawed, is troubling from the point of view of respecting Zephyr's protectable financial interests and revealing about the strength of Brown's perceived obligation not to undermine his client's professional reputation.

This first episode had a second ethically problematic aspect, one which contributed to the first. By his own admission, during Smith's presentation at the meeting with Zephyr it "became obvious" to Brown that Smith's "proposed solution created far more new problems than it attempted to solve." Nevertheless, Brown's decision to become a consultant for Smith and apparent willingness to attend the meeting with Zephyr in the role of endorser of Smith's method and approach ***before checking on their validity and viability*** invites criticism. Brown seems blameworthy for not investigating the workability of Smith's plan before agreeing to put himself in a situation where he would be subject to strong pressure to dissemble or prevaricate. For, it may be argued, he knew or should have known that he would be expected to support his client's proposal at the meeting. Moreover, given his "simple business ethic," he should have realized that, independent of its merit, he would be extremely reluctant if not unwilling to say anything that would invalidate or cast doubt upon his client's program and thereby his reputation. In effect, Brown seems to have inadvertently put himself in a position in which he was foreseeably confronted by a classical conflict of interest. For respecting the legitimate financial interest of his indirect client, Zephyr, and the safety interest of the bicycle riding public could easily come into conflict with protecting the professional reputational interest of his direct client, Smith.

It turns out, however, that the above depiction of events in and around this first episode, an account based upon Brown's initial written case study and on the 1995 class session, is too thin and tidy. It does not do justice to the complexities and dynamics of the sociotechnical engineering situation Brown actually faced. While consistent with Brown's original written case study and initial class discussion, the above account and analysis rest upon several important explicit and implicit assumptions. For example, they assume that Brown was unaware of drawbacks of Smith's concept prior to the meeting with Zephyr and that Brown knew or should have known that he would be expected to endorse or validate Smith's plan at the meeting. Upon further inquiry, both assumptions prove to have been invalid. Let us briefly consider each in turn.

First, Brown had had several meetings with Smith about his proposed solution idea well before the meeting with Zephyr's staff. At them Brown had "expressed his concern [to Smith] that for fundamental reasons his solution did not appear to be workable." (CS97) Indeed, prior to their

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irredeemably flawed. Only when pressed did he reluctantly acknowledge that there could be circumstances in which he would feel morally compelled to "sabotage the relationship" with a client in full view of the latter's own client, e.g., if the client were trying to "foist something on the marketplace that we knew was bad" (read: unsafe). (C97)

[6]The latter, of course, is something engineers are morally obligated not to do according to the first fundamental canon of many codes of engineering ethics: "hold paramount the safety, health, and welfare of the public in the performance of their professional duties." ("Code of Ethics for Engineers," National Society of Professional Engineers [NSPE], NSPE Publication Number 1102, January 1990, Section I.1.) No exception to this obligation is made when the engineer in question is in the employ of another consultant. Indeed, the NSPE Code of Ethics states explicitly that engineers shall "at all times" recognize that their "primary obligation" is to "protect the safety, health, property and welfare of the public" (*ibid.*, Section II.1.a), a position that in this case effectively came into direct conflict with Brown's "simple business ethic."

meeting with Zephyr, Brown had already presented Smith "with several optional approaches to [solving] Zephyr's problem which did address the unworkable aspects of his initial concepts." (CS97) What Brown realized at the meeting with Zephyr was not what he already knew—that Smith's approach was structurally flawed—but that Smith's concept "created far more new problems than it attempted to solve." But since Brown had conveyed his concerns to Smith before the meeting with Zephyr, Brown's obligation not to undermine his client's reputation and credibility was significantly diluted if not completely dissolved by Smith's public request for validation from the very person who had previously told him in private that his proposed solution idea was structurally flawed.

Second, far from understanding that he was attending the meeting with Zephyr to endorse or validate Smith's ideas, Brown was in fact "surprised" (CS97) that Smith called upon him during this meeting to validate what Brown regarded as "a very creative, clever, but highly unworkable solution." (C97) Given its early stage of development, he regarded Smith's solution idea as distinctly "premature" for endorsement or adoption. (CS97) Brown was taken aback by Smith's request to validate because he saw his role entering the meeting as that of a consulting engineer with expertise in composite-material structures who had been engaged by a client and invited by him to participate in a three-way meeting the purpose of which, he assumed, was to jointly "explore problems" with Smith's embryonic ideas. That he was taken aback by Smith's endorsement request is clear from Brown's statement that "What I don't know to this day is whether [Smith] felt that he was under pressure to perform on this contract and needed to produce a positive response in the manufacturer as to his performance. Those are things I don't know, but they could easily have been motivational factors that would have influenced why he *put us on the spot*." (C97) (emphasis added)

In light of this less tidy situation, review of moral judgments about Brown's conduct based on the simpler account initially offered is in order. First, was Brown's initial dissembling and evasiveness morally blameworthy? While he did dissemble and prevaricate, Brown "respected, and had confidence in, Zephyr's ability to discover the potentials and pitfalls of Smith's concept." (WC97) He felt it would "serve no purpose to deny Smith an opportunity to present and defend his recommendations to Zephyr," especially since Brown's "assessment of the situation and personal dynamics [at the meeting] was that Zepyhr's funding commitments would only be toward engineering [and] technology validation at this time and that production funding would be based on demonstrated merit." (WC97) Whether this more complex state of affairs suffices to absolve Brown of any moral blame for his feigned ignorance depends on whether his confidence was well grounded that Zephyr would in fact discover by itself the pitfalls of Smith's concept. On the one hand, if Brown had good reason to think that Zephyr would probably discover these pitfalls on its own before losing significant money, then his evasive behavior would seem to be ethically defensible. On the other hand, to the extent that he lacked good reason to think that Zephyr would discover the flaws before spending a significant amount of money on Smith's unworkable ideas, then his lack of candor would be ethically problematic, especially if, as argued above, Smith's knowing endorsement request of Brown at the meeting with Zephyr released Brown from any moral obligation he had to avoid doing anything that might damage his client's professional reputation.

Second, what of Brown's "apparent willingness to attend the meeting with Zephyr in the de facto role of endorser of Smith's method and approach *before checking on their validity and viability*"? It now appears that, on the contrary, Brown clearly recognized and explicitly told Smith prior to their meeting with Zephyr of serious flaws in Smith's method and approach and did *not* accept before the meeting the role of blithe endorser or rubber-stamp validator of Smith's flawed solution idea. This revised depiction of the reality of Brown's state of knowledge and role understanding absolves him of any charge that he was negligent in being willing to attend the Zephyr meeting as endorser without first checking out the validity of Smith's ideas. As Brown put it, his notion of the purpose of the meeting was that it was to be devoted to jointly "exploring problems" with Smith's ideas, not to "foisting [flawed] solutions" on a skeptical manufacturer by allowing his expertise in composite structures to be exploited by his client. (C97)

This first episode suggests a general lesson for engineering ethical theory, practice, and pedagogy. Subtle, elusive, context-specific factors can be vital to sound prospective ethical decision-making and fair retrospective ethical judgment-making. For example, the temporal juncture at which a triangular episode such as that described above occurs in a dynamic, evolving engineering process can bear on the question of whether an agent's act of omission or commission is reasonably regarded as creating an unreasonable risk of harm to protectable public or private interests. A secondary consulting engineer's state of knowledge about the viability of a client's proposal and her or his reasonable expectations regarding the role he or she is expected to play in a three-way meeting about that proposal can also matter ethically, for example to judgments of professional responsibility or negligence. The same is true of a secondary consultant's reasonable notion of the purpose and agenda of a meeting called by her or his client that includes important representatives of the client's client. All three contextual factors merit scrutiny in reaching equitable conclusions about a secondary consultant's conduct and judgments, phenomena that may, as in the present case, seem ethically indefensible at first glance. Role assumptions and perceived purposes may be illusory because of deception by the original consultant or because the latter deliberately or inadvertently underspecifies roles or meeting purpose and agenda to his own engineering consultant. As this case shows, if left unclarified, manipulated or misconstrued role expectations or assumptions of meeting purpose and agenda may put a secondary engineering consultant in a delicate ethical position requiring difficult ethical choices.

If there is a specific moral to be derived from this first episode it is that engineers and other secondary technical consultants should be exceedingly careful before allowing their potent expertise to be deployed in third-party situations where important decisions may be made on the basis of their actions of commission or omission. A secondary technical consultant should make a reasonable prior effort to determine to the best of her or his ability what her or his role is and what the purpose and agenda of such a meeting is to which he or she will bring expertise able to decisively affect a participant party's protectable interests. If prudence is a virtue for engineers and other technical experts, then reasonable exercise of caution prior to the commencement of such situations is ethically obligatory for such professionals, the more so to the extent that decisive decision-making is possible and noteworthy safety or financial considerations are at stake. Moreover, given the pragmatic difficulties of exercising such caution beforehand, the question may be raised whether a secondary engineering consultant with potentially decisive technical expertise should *ever* permit it to be deployed in a three-party meeting situation called by her or his client if that person has not previously *earned* the engineer's trust, something which would at least justify assumptions that proffered notions of role and agenda are reliable and not likely to create ethical minefields.

EPISODE 2. JONES ASKS BROWN TO EVALUATE SMITH'S APPROACH

Later on in the meeting, Jones, Zephyr's director of R & D, asked Brown "point blank" whether or not he thought Smith's was a workable approach, "a yes/no alternative that forced a major breach of ethics with either answer, since I believed it was an unsound and unworkable concept." Brown presumably means that had he answered "yes, it's a sound and workable approach," that would have eventually harmed his and his own company's reputation with Zephyr, with a "long-time [composite-materials] supplier [of Brown's] who sat in on the meeting," and with any other knowledgeable parties who learned of what would be a dishonest endorsement. The harm done to his company's reputation would also indirectly harm important economic interests of Brown's own employees. On the other hand, had he answered "no, it's an unsound and unworkable concept," that "would have destroyed [Smith's] business relationship with his client." In the event, Brown gave an answer that he believed "maintained everyone's integrity": viz., "to confirm that my direct relationship to the bicycle company was through [Smith] and that we [Brown's company] would work with the consultant to address issue[s] which were important to the client's requirements."

Beyond indicating that "maintaining everyone's integrity" was Brown's top priority at this juncture, his answer was arguably defensible. For, to an experienced listener, his refusal to answer Jones' question substantively, unequivocally, and without hesitation could not but heighten Zephyr's doubts about Smith's approach and make it more cautious about adopting it—and Brown probably realized that. If Brown had no misgivings about the plan, Smith would not have wanted him to hide that fact and take refuge as he did in a chain-of-command formalism. In this sense, Brown's reply, although neutral on the surface, invited the interpretation that he regarded the plan as problematic, something which, whether or not intended as such, probably served as a valuable yellow flag to Zephyr. Therefore, Brown's reply here to Jones' question was effectively less evasive and more cautionary than his earlier response to Smith's request.

EPISODE 3. ZEPHYR SEEKS TO ESTABLISH A DIRECT RELATIONSHIP WITH BROWN

The limitations of Smith's design and manufacturing concept "became more evident to the client [Zephyr] as these issues were brought forward." Zephyr eventually approached Brown without the knowledge of Smith and confided that it wished to begin a relationship with Brown's company and bypass Smith altogether. However, to his substantial moral credit, Brown felt it would have been unjust to Smith to commence such a relationship since it would have deprived of business the very engineer who had brought him to this opportunity in the first place. He stated that he would countenance such a relationship only after Zephyr terminated its relationship with Smith. Further, Brown waited until Smith informed him that his relationship with Zephyr had been terminated before entering into a direct relationship with the company. Finally, because Smith had already done work that "saved [Brown's company] five or six months of energy and effort," (C97) Brown promised Smith a portion of the royalties he ultimately earned from sales of the bicycle he designed for Zephyr: "I just felt that there was some reward due and that he [Smith] should not be cast out with the bath water." (CS97) Brown's admirable sense of propriety and concern for fairness to Smith may have enhanced his credibility in Zephyr's eyes as someone who in his business relationships is not completely driven by short-term profit maximization. This should and hopefully did have an edifying effect on Zephyr regarding making future overtures to consultants of consultants while the former are still under contract to their respective clients.

EPISODE 4. TO OPTIMIZE OR NOT TO OPTIMIZE

When Brown entered into a contract with Zephyr, the "original problem statement" was "to design a composite frame that was equal in strength and equal in stiffness to the existing [tubular metallic] frame." (CS95) After developing a working manufacturing plan for composite bicycles, Brown made an important decision. Because the composite analysis was so much more complex and therefore more costly, "we suggested that we make certain that the frame [Zephyr] had given us as a baseline was in fact as good as it could be before we departed [from it] and tried to make that same frame out of some . . . advanced material."(CS95) But, to his surprise, when he asked Jones for permission to optimize the existing frame, he was told not to do so, something Brown felt was "a very shocking thing for him to say until I [learned] subsequently that [Jones] was its designer,"[7] (CS95) and that his "design ego" was the main factor driving his prohibition. (CS97)

Brown could easily have taken that "no" for a definitive answer and acted accordingly. However, he "decided to go off the customer's book and if we found something that was of note on our own invested nickel, then we would bring it to the customer's attention." (CS95) In the event, what he found was that the design of the existing tubular metallic frame was "nowhere near where it should have been to be the appropriate baseline to solve the [composite] problem." (CS95) The stated reason why Brown undertook to optimize the frame

[7] Jones' "design ego" (CS97) did a potential disservice to his employer by instructing that certain methodologies not be used that might have improved (and in the event did lead to improvements in) a product he himself had designed. This posture would seem to be at odds with the engineer's moral obligation to do the best that he or she can to serve the legitimate business interests of his or her employer or client.

on his own time and resources was that he regarded optimization of the existing frame as "an essential, sound engineering practice." (CS95) As he put it, "if you're going to design an experiment and the objective is to make something the best you can, and you have a baseline to start with as your point of reference, your control, if you will, and you find that there's something wrong with that control that's going to throw off the whole experimental base that you're trying to accomplish, . . . so we wanted to make certain that the control was in fact as refined as it could possibly be so that all of the rest of the work that we had to accomplish would be based on the best answer [for] their existing technology." (CS95)

Given the terms of his contract, optimization was not only not legally binding on Brown, he was expressly told not to do it. Nevertheless, I contend that in this case optimization was not only morally permissible but morally obligatory for Brown. His obligation to optimize did not stem from the fact that optimization is an element of good engineering practice as such. After all, not everything that is "good engineering practice" is morally obligatory for engineers, e.g., bench-marking, careful record keeping, and fastidious literature searches. Rather it stemmed from two other considerations.

First, engineers have a general moral obligation to act so as to serve the legitimate interests of their clients or employers as well as they can. For the design engineer, this general obligation ramifies into a more specific obligation to design the best product or process that meets the given specifications under the specified constraints.[8] This, Brown reasonably believed, required optimization of the existing frame. For to proceed without optimization would be akin to a surgeon performing an important, innovative operation on a patient after having acquiesced to the order of a member of the patient's family, unbeknownst to the patient, not to carry out an exploratory diagnostic procedure which could significantly enhance the prospects for a successful surgical outcome. The specific obligation to optimize derives at two removes from the engineer's general obligation to serve the legitimate interests of the employer or client to the best of her or his ability.

Second, this derivative obligation was strengthened by the fact that Brown's task called for him to go beyond what Walter Vincenti, extending Thomas Kuhn and Edward Constant, calls "normal [engineering] design" and to enter the realm of "radical [engineering] design."[9] One enters this realm when the "configuration," the "operational principle," or, as in this case, the structural material of an item of technology constitutes a marked departure from the reigning, well understood normal design paradigm.[10] The obligation to assure that the baseline frame was optimal in design stems from the fact that "composites are unique" and "tricky" (CS95) and sometimes behave in ways that are not yet adequately understood. Moreover, composites, although very strong and very stiff, are "very brittle and don't give much external evidence of internal failure." (CS97) Therefore, optimizing the structure of the old frame in terms of strength and stiffness would provide a baseline to refer to when evaluating the behavior of the composite frame under critical load conditions. Without this baseline, it would have been impossible for Brown to know whether he was designing the best product for his client, hence was serving the client's interests to the best of his ability. For without optimization, the new composite frame might have been lighter than the existing frame but, unbeknownst to the designer, not appreciably lighter (and possibly less reliable) than the optimized, more cost-effective, tubular metal frame. In his determination to carry out the "essential, sound engineering practice" of optimization, even at his own expense, Brown exhibited exemplary moral character and good engineering judgment.

[8]This obligation holds as long as the constraints specified are not such that observing them calls into question the safety of the ensuing product or process.

[9]Walter G. Vincenti, "Engineering Knowledge, Type of Design, and Level of Hierarchy: Further Thoughts About *What Engineers Know*," in P. Kroes and M. Bakker, eds., *Technological Development and Science in the Industrial Age* (Dordrecht: Kluwer Academic Publishers, 1992), pp. 19–21.

[10]The expression "normal configuration" is due to Vincenti, while "operational principle" is due to Michael Polanyi. See Vincenti, *op. cit.*, p. 20, and Polanyi, *Personal Knowledge* (Chicago: University of Chicago Press, 1962), p. 328.

EPISODE 5. OPTION DISCLOSURE AND PROBLEM REDEFINITION

As a result of his optimization study, Brown determined that for an incremental manufacturing cost burden of $6.20/bicycle and with a change in only a couple of materials used in making the bicycle, the existing metal frame could be reduced in weight by a third, bringing it within about 2 oz. of the target weight of the projected composite-material bicycle. Moreover, this could be done "without adding about $2 million in capital equipment, without adding a total secondary staff of people who [would have] had to learn new skills . . . not totally available in the . . . marketplace, apply these new skills to the new equipment, go through the learning curve headaches, and come up with an optimally designed and manufactured corporate product." (CS95)

Given all this, Brown felt obligated to disclose this new option to Zephyr. Why? As he put it, "it is my job to provide [the people employing us] with full and complete information so that the conditions under which they employ us are honest and viable. . . . [B]y withholding information that's essential to their decision-making process, I'm not being honest and complete in the service I provide. . . . It's simply our job to present alternatives that are either known in advance or that come up in the course of our investigation."(CS95)

Brown's remarks here conflate two kinds of consideration: (1) considerations of moral character and (2) considerations of the employer's best interests, here in making sound decisions. The obligation to disclose the alternative production option stems not just or primarily from the fact that honesty is a virtue, but from the fact that option disclosure was necessary if the client's decision making was to be made sound by being informed rather than remain vulnerable by being uninformed.[11] For the company's production decision about whether to proceed with development of a composite bicycle to be informed, it had to be based on knowledge of the range of options available to it, including the improved non-composite option. If a consulting engineer has a moral obligation to serve her or his client's or employer's legitimate interests to the best of her or his ability, and if making important decisions on an informed basis is a legitimate client or employer interest, and if a consultant acquires information bearing substantially on her or his client's ability to make such decisions on such a basis, then option disclosure here was morally obligatory for Brown. He so regarded optimization and option disclosure and acted accordingly. For example, beyond optimizing the existing frame at his own company's expense, Brown participated in conference calls with the president of Zephyr and his director of R & D, during which he informed the president that he had been told not to optimize but that he considered doing so essential, for reasons of "product liability, consumer issues, [and] safety issues." (CS97)

But for Brown, serving the best interests of the client went beyond ***optimization*** and ***option disclosure***. It also encompassed ***problem redefinition***. Instead of just "make us a carbon-fiber bicycle," Brown helped Zephyr see that its goal was "[to make the] best possible product, given all possible perspectives of the problem." (CS95) This in turn involved helping the client see that "the real problem" was "to build a lightweight bicycle frame that was equivalent in strength to their existing frame," (CS95) whether made out of a fiber-reinforced composite material or out of a less exotic metallic material.

This is a robust and ethically admirable notion of what it is for an engineer to serve the legitimate interests of one's client to the best of her or his ability. It enabled the client to choose between a new, expensive-to-manufacture, composite-material bicycle of uncertain structural reliability, and a redesigned, much-cheaper-to-produce, reliable metal-tube bicycle, as strong and almost as light as the composite. Had Brown's notion of serving the legitimate interests of a client as well as he could been subsumable under the simple "uncritically-follow-the-client's-marching-orders" model, an expensive-to-manufacture and possibly sub-optimal carbon-fiber bicycle would have resulted and been the sole lightweight bicycle option available to Zephyr. Paradoxically, the general obligation of the engineer to serve the best interests of the client as well as he or she can here

[11]Brown believed that manufacturing 300 to 350 bicycles a day out of fiber-reinforced composite materials could "expose the company . . . to significant product liability claims."(C95)

laid upon engineer Brown a derivative moral obligation to challenge and attempt to effect revision of the problem formulation originally given him by his client. Like the case of William LeMessurier and the Citicorp Building,[12] the composite-material bicycle case suggests that fulfilling the consulting engineer's obligation to serve the interests of the client to the best of her or his ability is not always simply a matter of deploying state-of-the-art technical competence to achieve what is requested of one. Sometimes fulfilling that obligation requires having the courage of one's convictions, in this instance of undertaking to do exactly what one was told not to do, and of deftly exercising various diplomatic, organizational, and communications skills. In taking the path of option disclosure and undertaking the task of problem redefinition, engineer Brown once again exhibited exemplary ethical conduct. It would have been easier for him to have kept knowledge of the new lightweight option to himself, or to have conveyed it only to Jones, with whom, for obvious reasons, it would probably have remained a closely held secret.

IV. Conclusion

Medical ethicists have begun to recognize that general human rights, like the rights to life and liberty, ramify in interesting ways in contemporary technological and professional-medical contexts, and that the resultant derivative moral rights sometimes require careful delimitation and qualification. Similarly, engineering ethicists should explore how general moral obligations of engineers give rise to more specific derivative moral obligations as a function of, among other things, the kind of engineering work being done and noteworthy features of the context in which that work unfolds. In the composite-bicycle case, general moral obligations of the engineer to serve the employer's or client's legitimate interests to the best of her or his ability, and to hold paramount the health, safety, and welfare of the public, gave rise to more specific, derivative moral obligations to optimize, disclose options, and attempt to effect problem reformulation. This ramification reflects the fact that non-normal engineering design work was being done involving the use of an advanced, not-well-understood material, the fact that the design work unfolded in a context in which substantial company money was at stake, and the fact that public safety was potentially at risk. Elaborating middle-level moral obligations of engineers as functions of the features of the total socio-technical contexts in question could help turn general formulations of engineers' moral obligations easily embraceable in the abstract into agendas of specific challenging tasks that engineers are morally obliged to fulfill in particular kinds of contexts.

Addressing intending engineers uneasy about the prospect of facing vexing ethical issues and making difficult ethical choices in their future practice, Brown concluded his written case study with a provocation: "My advice to you is to get out of engineering quickly and seek career opportunities in investment banking, stock brokerage, real estate, auto sales, or life insurance and financial planning." Brown here implicitly contrasts the listed fields and engineering. In the former, it is deemed legitimate to persuade a customer that he or she needs something in fact not needed, this in order for the practitioner to make money. In contrast, for Brown it is sometimes ethically incumbent upon the engineer to attempt to persuade the client that something it thinks *is* needed is actually *not* needed, even if success in doing so means the engineer foregoes an opportunity to make money. This is a high standard of professional responsibility, one which Brown met and which future engineers must be prepared to meet if they aspire to call themselves true professionals. In light of this imperative, engineering educators have a derivative moral obligation of their own: to labor upstream with their students, such that, duly apprised of and equipped to grapple with the sometimes daunting ethical challenges of engineering practice, their career decisions will be more informed and truly voluntary. If, and perhaps only if, intending engineering professionals are so prepared, then radical downstream career changes, such as that urged by Brown, will become as unnecessary as they are upsetting.

[12] See Joe Morgenstern, "The Fifty-Nine Story Crisis," *The New Yorker,* May 29, 1995, pp. 45–53. Reprinted in the *Journal of Professional Issues in Engineering Education and Practice,* January 1997, pp. 23–29.

Discussion Questions

1. When Smith asked Brown to validate his technological expertise, Brown withheld important information from Zephyr. Did Brown violate any ethical standards? Legal standards? Professional codes of ethics?
2. Do you see any problems with Brown's decision to represent him before he really understood Smith's technological strategy? What morals can be derived from the first part of this story?
3. In episode 2, Brown appears to have withheld important information from Jones, Zephyr's director of R & D. Do you see any ethical problems with his answer? How would you support your answer?
4. From McGinn's perspective, did Brown exhibit good moral and engineering judgment when he carried out his own experiments of optimization of a new composite bicycle frame? Why or why not? Do you agree with McGinn's perspective?

Cases

Case 6-1

Jennifer had high hopes when she graduated from college with an engineering degree. During her last year in college, several companies interviewed her, and she in fact received several job offers. The company she chose recruited her heavily. They made many promises to her and offered a nice benefit package. Unfortunately, the reality of her working environment did not match the glowing picture the company had painted. Within the first year of her employment, Jennifer found herself embroiled in a fight with her colleagues. Her company was indicted as part of a lawsuit for a defective product. Management was taking most of the heat; however, Jennifer knew that the proper blame belonged to the engineers who knew ahead of time that there was a reasonable chance of product failure. When she brought this up in conversations, she was often faced with defiant attitudes: instead of comaraderie, coldness; instead of objectivity, aloofness; instead of caring, selfishness. Worst of all, instead of institutional support, she found fear and suspicion. Jennifer spent one year at her job before she found another place of employment, one that was more in line with her values and engineering ideals.

1. Using Moriarty's understanding of engineering practice, discuss the problems Jennifer faced in her original engineering firm.
2. In light of Jennifer's case, and keeping in mind Moriarty's virtues of caring and objectivity and Judith Andre's article (from Chapter 4), write a paragraph entitled, "My Work, My Enemy."
3. From your point of view, what is the relationship, if any, between the virtues of objectivity and caring, and the roles of moral rules and professional codes? How could your answer translate into a recommendation for Jennifer's first company?

Case 6-2

"Have you said anything to your wife about this? Your decision will affect her as much as it will affect you. And what about your kids? Have you thought about how it might affect them? You may have to move. And what about your family's needs? They've become accustomed to a certain kind of life. If you move ahead and blow the whistle, everything will change. You may never even work in the industry again. Think about all your education, about your plans and goals." Douglas is trying to talk some sense into his friend, who has discovered that the managers of his company knowingly let a product on the market with a defect. The defect is beginning to hurt people, mainly children. Further, his friend has discovered that the problem could be solved with a relatively inexpensive $14 part. Since there are no government industry standards, however, the company will wait until forced by the government to attend to the defect, thinking that this is the more profitable move. Douglas's friend thinks it is his duty to bring this to the attention of the public, but Douglas knows, having seen this kind of situation before, that his friend will be fired and will almost certainly never work again as an engineer because of his reputation as a whistleblower.

1. Many people would argue that Douglas's friend has a moral duty to blow the whistle on the company and managers. What reasons are there to do this?
2. Douglas's friend has a family. Nevertheless, he still wants to blow the whistle. Should his friend consider the impact his decision will have on his family? In this case, are his family obligations morally relevant? How, exactly, should he "weigh" his obligations to the public against his obligations to his family?
3. How well could an argument against whistleblowing, based on a duty of loyalty owed to the company, be constructed? How, exactly, would the duty of loyalty be "weighed" against the duty to warn the public?
4. While blowing the whistle seems to support the virtue of self-direction and the public-spirited virtues, it seems to undermine teamwork virtues. Why is this so? How could blowing the whistle undermine the virtue of self-direction?

Case 6-3

"You know, Jeff, the reason you're so upset is that you're young and idealistic. School has put a bunch of crazy notions in your head. Forget about saving the world and concentrate on your career." Perhaps youth and idealistic tendencies do motivate Jeff Johnson, who is part of a group of junior engineers hired by Engineers R Us, Inc, but even if this is true, it overlooks the fact that the memo Jeff has written points to his commitment to the importance and paramountcy of protecting the public's welfare. Jeff has detected a flaw that introduces an element of risk, a risk that he believes is unacceptable. The supervisors of the project, however, respond negatively on two levels. First, they claim the element of risk is acceptable. Second, they say that the complete insulation of the public's welfare is unrealistic.

1. Jeff's attitude about the paramountcy of public health is different from that of his supervisors. What is the main difference? Who do you think is correct?
2. How would Broome's revised notion of public paramountcy apply to this case and to Jeff's views? Would the revised notion help Jeff determine whether, if things got that far, he should blow the whistle?
3. To what extent do you agree with the supervisors' response that guaranteeing the public safety is not possible, since risk is an inherent part of engineering? How does this response bear on the decision to overlook the flaw and proceed?

Case 6-4

Robert Ludlum is an engineer. He designs tires for Tires R Us, Inc. One day he comes across one of his colleague's designs and notices an important flaw, one that might have disastrous results. Because the design of the tires is intended for sports recreational vehicles (SRVs), the problem is aggravated by the higher than usual center of gravity. A blowout may cause the SRVs to flip over. Ludlum seeks advice from his supervisor, but she is not convinced that he is right and attempts to set Ludlum's fears at ease. While Ludlum is not afraid to bring this to the public's attention if he has to, he is nevertheless bound by an oath of loyalty to attempt to solve problems like this within the company first. He decides to go over her head, which is his right according to company policy. The situation is also complicated because the design of the tires employs a trade secret. Ludlum knows that if he has to go public with this information, he may be required to prove his case, which can be done only by revealing the trade secret.

1. In light of Schlossberger's essay, what sorts of considerations are relevant to Robert Ludlum's decision process about going public? What would Martin add? What would Broome add? What would Moriarty add?
2. From your understanding of Schlossberger's article, does Ludlum's problem constitute a legitimate reason to go public? Does it represent a situation in which a trade secret may be revealed, or even should be revealed?

Case 6-5

Aeronautical Astronomics, Inc., has designed a new airplane to compete with airplanes now in service with the military. The airplane is faster, more maneuverable, and more resilient. Because of its speed, Aeronautical Astronomics has also designed a new braking system that is needed to anticipate the special requirements of such a fast plane. In order to guarantee the reliability and trustworthiness of the braking system, Aeronautical Astronomics has sent its designs to an engineering firm that specializes in such systems called Brakes R Us, Inc. After her initial inspection, the senior engineer on the project realizes that while the basic design is stable, the braking system could be improved in certain ways, and that the improvements are also financially and technically feasible. When she informs Aeronautical Astronomics of her findings, the spokesman of Aeronautical Astronomics communicates to her, in no uncertain terms, that no improvements of the basic design are required or wanted. The senior engineer tries her best to convince him otherwise, but to no avail. Finally she lets the design go and authorizes the basic invention.

1. In light of McGinn's article, what was the senior engineer's moral obligation, if any, to Aeronautical Astronomics, Inc., when she envisioned the brake system improvement? Did she have any professional obligations to Aeronautical Astronomics, Inc., to improve the braking system?
2. While improving a braking system seems reasonable, what reasons could Aeronautical Astronomics, Inc., have to ignore the senior engineer's suggestions? Are engineering firms under any obligation to design and manufacture products of a certain minimum quality? If so, explain. How does your answer apply to this case?
3. After the senior engineer's ideas were turned down, she dropped her case and authorized the basic design. In your opinion, do you think that authorizing such a design is advisable? Are there any ethical, professional, or even personal issues at stake here?