Chapter 14
Engineering Ethics: From Preventive Ethics to Aspirational Ethics

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Abstract An important distinction in engineering ethics is between preventive ethics, which consists of guidelines for preventing harm to the public, and aspirational ethics, which consists of guidelines and motivating considerations for using one's professional expertise to promote human well-being. Preventive ethics is stated in rules and is considered mandatory for all members of a profession. Aspirational ethics allows the professional more discretion in determining what it involves and when and how it is implemented. While preventive ethics must continue to be an important part of professional ethics in engineering, aspirational ethics should be given a more prominent place. Four types of action falling in the category of aspirational ethics can be distinguished, based on their increasingly direct focus on promoting human well-being. Four virtues can be identified as having special importance in motivating and guiding aspirational ethics.

Keywords Professional ethics • Aspirational ethics • Preventative ethics • Virtue ethics

14.1 Preventive Ethics

Engineering ethics can be divided into two areas. "Preventive ethics," which might also be called "regulatory ethics," consists of guidelines for preventing harm to the public. Preventive ethics in turn can itself be divided into two components. The first component is ethical guidelines designed to prevent specific types of professional misconduct, such as violating confidentiality when it is not justified, having an

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undisclosed conflict of interest which corrupts one's professional judgment, and practicing outside one's area of professional competence. Such guidelines supply most of the content of the engineering codes of ethics. By my count, 80 % of the content of the code of the National Society of Professional Engineers (NSPE) is devoted to this type of regulation.

The second and more general component has to do with directions to exercise the proper degree of professional responsibility in one's work. Although these larger aspects of engineering responsibility are rarely mentioned in the codes, they follow from the directive present in most engineering codes to "hold paramount" the safety and health of the public, and they are often discussed in textbooks and other documents in engineering ethics. Engineers, for example, must exercise "due care" or "reasonable care" in the performance of professional duties. This requires more than merely exercising that minimal degree of responsibility necessary to avoid legal problems. Engineers must act in an anticipatory and proactive way, attempting to eliminate possible problems before they arise and even identifying and correcting problems caused by other engineers, when practically possible.

Preventive ethics has been the center of attention in the emerging discipline of engineering ethics. Much of the impetus for preventive ethics has come from the so-called "disaster cases" that have aroused public concern and demonstrated the need for protecting the public. A mining disaster in Wyoming resulted in the creation of the first state board of registration for engineers in the US, and a natural gas explosion in a school in Texas resulted in legislation setting up professional registration in the state. The Hyatt Regency walkway collapse also caused widespread concern about structural safety. The *Challenger* and *Columbia* crashes are probably the preeminent examples of disaster cases that caused public concern about safety in engineering.

Engineers can exhibit adherence to preventive ethics in various ways, some of which have been suggested already, such as avoiding conflicts of interest or anticipating and preventing events that can adversely affect the health or safety of the public. But the ultimate manifestation of preventive ethics is "whistleblowing," which often involves risking one's job or even one's career to protect the public. The best-known justification of whistleblowing, by Richard De George, holds that whistleblowing is only morally obligatory when one has evidence that would convince a responsible, impartial observer that organizational policy is wrong and strong evidence that making the information public will prevent serious harm to the public. De George's argument thus aligns itself with the preventive-ethics orientation (De George 1981).

In summary, preventive ethics, insofar as it applies to engineering, has three characteristics. First, its precepts are designed to protect the public from harm, either from technology itself or from the misconduct or lack of responsibility on the part of engineers themselves. Second, the provisions of preventive ethics are mandatory. They are ethically mandatory, because they appear in the codes or are implied by the obligation to hold paramount the health and safety of the public; they may be legally mandatory if engineers are registered by a governmental entity. Third, since the major obligations of preventive ethics are set out by the engineering profession itself, in the codes and other documents in professional ethics, they are independent of the ideals or values of individual professionals. Individual engineers do not avoid conflicts of interest simply because such conflicts would violate their personal morality, but because conflicts of interest violate the standards set out by their profession. They learn that conflicts of interest are prohibited by the profession and that they must be avoided for that reason. Hopefully conflicts of interest violate their personal morality as well, but this is not the primary reason for avoiding them.

14.2 Aspirational Ethics

Despite the importance to the public of preventive ethics, it is difficult to conceive of it as comprising the whole of professional ethics. One does not enter a profession merely to avoid engaging in professional misconduct or harming the public. The best way to comply with these essentially negative aims would be to avoid becoming a professional altogether. Professional ethics in its highest sense must involve something more than preventing harm to the public. Let us call this more positive aspect of professional ethics "aspirational ethics."

One way to get at the more positive dimension of professional ethics is to ask, "What is the social good that a profession promotes?" For medicine, this social good is promoting health. The last of the nine Principles of Medical Ethics of the American Medical Association (AMA) says that the AMA "supports access to medical care for all people." While not specifying how this goal is to be achieved, the code endorses health as a social good for which medicine has a special responsibility. For law, the social good is generally thought to be the promotion of justice. To be sure, many attorneys may be more interested in promoting the interests of their clients than in seeking justice, but an argument can be made that the adversary system itself promotes justice, and that the work of lawyers in advocating the interests of their clients is an essential part of the adversary system.

What should be said about engineering? What is the social good for which engineering has a special responsibility? Engineering codes suggest an answer. The complete version of the "paramountcy" statement in the NSPE code referred to earlier says: "Engineers, in the performance of their professional duties, shall hold paramount the safety, health and *welfare* of the public."[1] While the references to safety and health are essentially negative and suggest a protective or preventive function, the term "welfare" suggests a distinctly positive ideal. I propose therefore that the social good of engineering is the promotion of the welfare of the public. But what does "welfare" mean? If "safety" and "health" refer to preventing harm to the public, to what does the term "welfare" refer?

Some hints for interpreting the term "welfare" can be found in the codes themselves. When discussing the obligation of engineers to "serve the public interest," the NSPE code, in section III.2.a uses the expression "safety, health and

[1] I have added the emphasis on "welfare."

well-being" instead of "safety, health and welfare." This suggests that "welfare" and "well-being" may be synonymous, thus confirming the more positive orientation of the term "welfare."

Other codes and sources give further grounds for holding that the term "welfare" should be given a more positive interpretation. The first sentence of the code of the Institute of Electrical and Electronics Engineers (IEEE) says that members of the IEEE recognize "the importance of our technologies in affecting the quality of life throughout the world…. "It goes without saying that "affecting the quality of life" means improving the quality of life. The first of the "Fundamental Principles" of the code of the American Society of Mechanical Engineers (ASME International) commits engineers to "using their knowledge and skill for the enhancement of human welfare…." Here the more positive interpretation—*enhancing* welfare—is explicit. The first of the "General Moral Imperatives" of the "ACM Code of Ethics and Professional Conduct" of the Association for Computing Machinery (ACM) directs computing professionals to use the products of their efforts to, among other things, "meet human needs."

Finally, a statement by William A. Wulf, then President of the National Academy of Engineering (NAE), gives clear and emphatic support for a more positive aim for engineering. Commenting on the NAE's selection of the 20 greatest engineering achievements of the twentieth century, Dr. Wulf said the criterion for selection was

> *not* technical "gee whiz," but how much an achievement improved people's quality of life. The result is a testament to the power and promise of engineering to improve the quality of human life worldwide. (Wulf 2000)

Enhancing human welfare, meeting human needs, improving the quality of human life—these are clear and unmistakable references to a positive ideal appropriate to the engineering profession. But how should we understand these terms? What sense of these terms is appropriate for the engineering profession?

14.3 Material Well-Being

The work of economist Amartya Sen and philosopher Martha Nussbaum is helpful in answering this question. In constructing criteria for measuring progress in developing countries, these writers have proposed the following approach. Let us define "functionings" as those activities that people value and "capabilities" as the abilities to engage in these activities and thereby "to lead the kind of life they have reason to value" (Sen and Anand 2000). Nussbaum has constructed a list of ten functionings, or activities that people value, which she believes apply to most humans around the world. We can consider these to be various aspects of welfare or well-being. In abbreviated form, these functionings are the following:

1. Living a normal length of life.
2. Having clean water, food, and shelter.
3. Moving about freely and safely.

4. Using one's senses and imagination and having free expression.
5. Having love and attachments to things and other people.
6. Being able to form a conception of the good life and to plan one's life.
7. Being treated with respect and dignity.
8. Living with concern for and in relation to nature.
9. Engaging in recreational activity.
10. Being able to participate in the political process, preserve material goods, and hold property (Nussbaum 2000).

It is noteworthy that engineering contributes to most of these functionings in some way. Medical technology helps to lengthen life. The contribution of civil engineering to the production of clean water and shelter is widely recognized, and the contribution of chemical and agricultural engineering to food production is equally evident. Free movement requires roads and the means of transportation, for which engineering is crucial. Free expression and attachment to others is facilitated by communication, including the use of computers. Being able to plan one's life and carry out those plans and being treated with respect and dignity are also facilitated by a minimal level of material well-being, which is facilitated by all branches of engineering. Being able to live in relation to nature and enjoy recreational activity are facilitated by transportation and other benefits of engineering. Finally, material goods cannot be preserved until they are first possessed, and engineering contributes to the production of material goods.

This enumeration points to an important fact, namely that engineering is especially associated with the material or physical factors that are important in enabling people to achieve a high quality of life or well-being. Therefore we can say that *the social good of engineering is the promotion of the material basis of human well-being or quality of life*. I propose that this is the good in view in aspirational ethics in engineering. In the next section, I suggest four ways in which engineers can promote the material basis of human well-being or quality of life, listed in terms of the increasing centrality of the goal of promoting human well-being. Let us refer to them as "aspirational acts."

14.4 Four Types of Aspirational Acts

Let us call the first category *Acts Exhibiting Exemplary Professional Excellence*, that is, actions that manifest the highest level of professional expertise and achievement. While preventive ethics may require minimal levels of professional competence, aspirational ethics advocates professional expertise and achievement that goes as far beyond this minimum level as the professional's capabilities allow. Although the direct and immediate focus is on attaining the highest level of professional excellence rather than promoting human well-being, the indirect result can be the production of engineering works of outstanding merit that increase human well-being.

The second category I call *Supererogatory Preventive Acts.* These are actions that are concerned with preventing harm to the health and safety of the public, but that go beyond what is required by preventive ethics. They are actions, like all supererogatory actions, that are praiseworthy, but not required. Richard De George's justification of whistleblowing, cited earlier, illustrates the distinction between a required action of preventive ethics and a supererogatory preventive action. For De George, if the evidence for the harm is overwhelming and if making the information public will almost certainly prevent the harm, the action is required and therefore falls into the category of (mandatory) preventive ethics. If, on the other hand, one can only say that the harm is serious, the concern has been reported to superiors, and the organizational channels have been exhausted, taking action to prevent the harm is supererogatory and falls in the category of aspirational ethics. Protesting the emission of a chemical from one's plant whose harmfulness is in dispute is also an example of a supererogatory preventive action.

Another example of a supererogatory preventive action is given in an opinion of the NSPE's Board of Ethical Review (BER). In case 82–85, the Board defended the right of an engineer to protest what he believed were excessive costs and time delays on a defense contract on the part of his employer. The BER's judgment was that, although the engineer was not ethically required to protest his employer's actions, he had "a right to do so as a matter of personal conscience." The reason cited by the Board to justify this right was that, in being concerned about the responsible expenditure of public funds, the engineer was looking after the welfare of the public. Here the welfare of the public is interpreted in terms of protecting the financial interests of taxpayers. Unlike actions in the category of preventive ethics, however, this action is described as non-mandatory. Furthermore, the action is described as deriving from the "personal conscience" of the engineer rather than strict professional obligations, as in the case of preventive ethics. Protecting the financial well-being of taxpayers when a threat to health and safety is not involved falls into the category of aspirational ethics.

The third category is what Michael Pritchard has called *Good Works* (Pritchard 1992). Professional activities in this category might be considered no different from any other type of engineering work, except that the public good is more clearly in mind, they are often highly innovative, they are frequently performed with a high degree of enthusiasm, and they sometimes involve an element of self-sacrifice. James is excited about being put on a project to develop an experimental automobile that has many recyclable parts, is lightweight, is unusually safe, and gets at least 60 miles per gallon of fuel. He works with unusual intensity and energy and is willing to put in overtime hours without pay to achieve the goals of the project. Students in a senior design class build an auditory visual tracker for use in evaluating the training of visual skills in children with disabilities. The students meet the children for whom the equipment is being designed, and this encounter so motivates them that they work overtime and even when the course is over to complete the project (Harris et al. 2009). A chemical engineer devotes his career, with some risk, to developing a highly efficient engine, a biomass conversion system, and other projects in "green engineering" (Harris et al. 2009, 191–192). In the 1930s a group of General Electric engineers, acting against considerable skepticism, worked overtime with no pay to develop a sealed beam headlight, which greatly reduced the number of accidents caused by night driving (Meese 1982).

I designate the fourth category as *Altruistic Engineering Acts*. Actions in this category are characterized by a still more direct focus on promoting public well-being, perhaps a deviation from a normal career path, and a special concern to utilize one's professional expertise to help those who are disadvantaged or in distress. At age 27, Frederick C. Cuny, who attended engineering school but was not a degreed engineer, founded the Interact Relief and Reconstruction Corporation. He organized relief efforts, involving engineering work, in Bosnia after the war and in Operation Desert Storm (Pritchard 1998). The work of engineers in Engineers Without Borders also falls into this category.

14.5 Characteristics of Aspirational Ethics

The above discussion suggests three characteristics of aspirational ethics. First, the provisions of aspirational ethics have a distinctly positive and idealistic element. Their orientation is not toward simply protecting the public from harm, but achieving the highest rungs on the ladder of professional excellence. In fact, the ideal of professional excellence is central in aspirational ethics.

Second, the provisions of aspirational ethics are non-mandatory, in that how and to what extent one implements them is a matter for personal discretion. While holding the welfare of the public paramount may be mandatory, it is left to individual engineers to determine how they will implement this provision. By contrast, the provisions of preventive ethics are more specific and ethically mandatory—even legally mandatory if the engineer has professional registration. Engineers may be condemned ethically and perhaps legally sanctioned for engaging in such practices as having undisclosed conflicts of interest or inappropriately revealing confidential information. These requirements are firmly grounded in the codes and other literature of engineering ethics. Aspirational ethics is different. Even failing to embrace aspirational acts altogether would not be cause for professional or legal reprimand, although it would involve an ethical failure of a lesser sort.

Third, the motivation for aspirational ethics, as well as the determination of how it is implemented, is in personal ideals, although these ideals may be importantly related to one's professional work. The BER ruling cited earlier hints at the personal grounding of aspirational ethics when it says that the engineer's decision to protest his employer's misuse of taxpayer funds was "a matter of personal conscience."

Mike W. Martin has even more clearly recognized the personal grounding of the aspirational aspects of professional ethics. Discussing the intersection of professional ethics with personal ideals, Martin says:

> Personal commitments motivate, guide, and give meaning to the work of professionals…I seek to widen professional ethics to include personal commitments, especially commitments to ideals not mandatory for all members of a profession. (Martin 2000)

One of Martin's favorite examples is Dr. David Hilfiker who "left a comfortable medical practice in rural Minnesota to work in a ghetto in Washington, D.C." According to Dr. Hilfiker's own testimony, his reason for doing this was to achieve a closer relationship with God (Martin 2000, 3). The examples in the category of altruistic engineering bear an obvious similarity to the example of Dr. Hilfiker.

As Martin stresses, aspirational acts are non-mandatory in nature. They are not grounded in rules promulgated in codes of ethics that are ethically (and perhaps legally) required. Rather, they are grounded in what the BER calls "personal conscience" and what Martin calls "personal commitments." They are grounded, that is, in traits of character. This means that they are grounded in what have traditionally been called virtues. I turn now to the nature of virtues and how they can serve as a grounding for aspirational ethics.

14.6 The Virtues

To begin, we can still profitably call upon Aristotle's definition of a virtue. For Aristotle, "…virtue or excellence is a characteristic [H. Rackham translates: "settled disposition of the mind"] involving choice, …that…consists in observing the mean relative to us, a mean which is defined by a rational principle, such as a man of practical wisdom would use to determine it." (Aristotle 1962) A virtue is a character trait which determines action, but not in a mechanical way. The determination of action must always be made "relative to us," i.e. relative to the circumstances of a particular situation. Moral judgment is necessary, for example, to discern what honesty requires in a particular situation. Further, as the definition also indicates, a virtue is something stable and abiding. Being courageous on one occasion is not enough to make one courageous, just as being cowardly on one occasion is not enough to make one cowardly.

Another important characteristic of a virtue is that it pervades the entire personality. Rosalind Hursthouse depicts the complexity of a virtue:

> A virtue such as honesty is a disposition which is well entrenched in its possessor, something that, as we say, "goes all the way down," unlike a habit such as being a tea-drinker—but the disposition in question, far from being a single track disposition to do honest actions for certain reasons, is multi-track. It is concerned with many other actions as well, with emotions and emotional reactions, choices, values, desires, perceptions, attitudes, interests, expectations and sensibilities. To possess a virtue is to be a certain sort of person with a certain complex mindset. (Hence the extreme recklessness of attributing a virtue on the basis of a single action.) (Hursthouse 2012)

The complexity and depth of the virtues is often overlooked, and it is an important consideration in determining how the virtues are to be taught.

A final point about the virtues that has been emphasized by contemporary research in social psychology may be contrary to Aristotle's understanding of the virtues. Aristotle appears to assume what Martha Merritt calls the "motivational self-sufficiency" of the virtues: that character is sufficient to motivate action (Merritt 2000). A vast body of social psychological research, however, casts doubt on "the Aristotelian certainty that a good upbringing, together with an accumulation of practical experience, is sufficient to secure virtuous dispositions as firm and unchangeable under normal circumstances" (Merritt 2000, 376). Instead, Merritt finds in social psychological research strong validation for "*the sustaining social contribution* to character" (Merritt 2000, 374). Effective transfer of the virtues as character traits to actual behavior appears to require social support. Without this support, individuals, influenced by the contingencies of the situation, may fail to consistently manifest the virtues in behavior. In the professions, this social support should come from professional societies and the professional community itself. Now I want to suggest four virtues that are of special importance in motivating and guiding the aspirational acts described earlier.

14.7 Four Virtues for Aspirational Ethics

The first virtue is *aspiration to professional excellence*, the disposition to achieve at the highest possible level in one's area of professional competence. Professional excellence can be linked to the more general Greek concept of excellence (*arête*), which is the quality that enables its possessor to perform his own particular function well. For the Greeks, it is the quality that enables a shoemaker to make good shoes or a warrior to be a good fighter. Excellence results in pride and satisfaction in a job well done, a job performed to the highest standards of the activity in question. Accordingly, an excellent engineer is one who performs to the highest standards of his or her profession. Minimal standards of competence are enforced by law and required by codes of ethics, but the aspiration to achieve the highest of which one is capable is not, and cannot be, mandated.

Since ancient times, many advocates of virtue ethics have maintained that the virtues can be taught. Teaching the virtues that motivate and guide aspirational conduct should be, therefore, an important aspect of moral education in engineering. Teaching the virtues has often been facilitated by the use of exemplars. While exemplars, such as Roger Boisjoly, have often been cited in engineering ethics for praiseworthy conduct in protecting (or attempting to protect) the public, it is also important to identify engineers for excellence in engineering work itself. Many exemplars could be cited in this category. Charles Steinmetz was important in the development of alternating current that made possible the expansion of the electric power industry in the U.S. Paul MacCready, inventor of the Gossamer Penguin, the first successful completely solar-powered aircraft, was cited by the Academy of Achievement as Engineer of the Century.

The second virtue is what Paul Taylor has called *respect for nature*, a disposition to appreciate and care for the natural world (Taylor 1986). It is a virtue that is important in motivating many good works, such as engineering projects devoted to protecting the environment. Engineering has more direct effect on the natural world than any other profession, so responsibility for environmental impact is a special obligation of engineers.

Rosalind Hursthouse has suggested that respect for nature is a "new" virtue. As she is the first to admit, however, inculcating a virtue is no simple matter, because a virtue involves a range of emotions, sensibilities, perceptions and in fact "a way of being human" (Hursthouse 2007). It might even involve "a complete transformation of character" (Hursthouse 2007, 163). One cannot simply decide to have a virtue, because its acquisition ordinarily (though not always) begins in childhood, before conscious decisions of this type are made. Training in the virtue of respect for nature is no exception. Its inculcation should begin in childhood and continue through adulthood.

An engineer might manifest the virtue of respect for nature in various ways, but the most obvious way would be a commitment to environmentally friendly engineering projects. Examples of engineers who have committed themselves to environmentally friendly project are also important (Harris et al. 2009).

How can the virtue of respect for nature be nurtured? For engineering students, exposing them to readings in environmental philosophy and literature, encouraging them to take courses in biology, and encouraging engineering professors to consider issues of environmentally friendly engineering and sustainable engineering come to mind. With young children, parents can encourage them to respect the lives of wild animals and not to kill them unnecessarily and to appreciate the beauty and intricacy of nature. "See that spider web? Isn't it beautiful? Don't tear it up when you do not have to."

The third virtue is also perhaps a "new" virtue, which I shall call *techno-social sensitivity*, a disposition to be aware of the effects of technology on society and to insure that these effects are as humane as possible. Hursthouse has reminded us that a virtue includes "sensibilities," which for our purposes can be taken as synonymous with "sensitivity" or even "awareness." This is an aspect of a virtue that is especially important here.

Even more than respect for nature, techno-social sensitivity is a virtue that students probably did not learn early in life. Furthermore, acquiring this virtue appears to be especially difficult for engineering students, as a recent study has indicated (Kuhn 1998). The primary vehicle for inculcating this virtue is probably exposure to the history of technology and, especially, exposure to the disciplines of Science and Technology Studies (STS) and the philosophy of technology. From these disciplines students learn about the effects of technology on human life and our perception of the world and other people. Some of these effects are salutary, but some are not. The increasing ability to dominate nature may have diminished our ability to experience the transcendent, and the effect of computer networking on the development of social skills may not always be to the better.

The fourth virtue is *benevolence*, the disposition to do good to others. Unlike respect for nature and techno-social sensitivity, benevolence is a long-recognized virtue. In the engineering context, benevolence is especially associated with supererogatory protection of the public from harm and promotion of the material well-being of the public, including the least advantaged.

Probably the best way to encourage benevolence is to encourage empathy (actually feeling the distress of others) or sympathy (having a compassionate or caring attitude towards the suffering of others). In a series of experiments, Batson showed that empathy/sympathy does indeed lead to genuinely altruistic motivation, and that it is best induced by imagining how one would feel in the situation of another (not how the other feels). Batson has probably also shown that empathy/sympathy is a causal factor in bringing about actual helping behavior (Batson 1991).

Encouraging benevolence in engineering students is probably best accomplished by means of service learning, such as the design project at Texas A&M mentioned earlier, and participating in projects sponsored by Engineers Without Borders.

14.8 Conclusion

Preventive ethics has been and will continue to be an essential aspect of engineering ethics, because the public must be protected from threats to health and safety and from the misuse of professional expertise by engineers. But preventive ethics does not, at least for the most part, connect with the highest professional ideals, or the personal motivations that give one's work as a professional their deepest meaning. Aspirational ethics should be given a larger place in the thinking of engineers and in the teaching of engineering ethics.

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