

Moral Responsibility for Engineers [with Commentaries]

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Moral Responsibility for Engineers

Kenneth D. Alpern

I

Technological knowledge gives us new and greater powers both to benefit and, as we have become increasingly aware, to harm ourselves. How are we to obtain the benefits and avoid the harm? One popular answer focuses on the individuals who design the products, conduct quality and safety tests, and directly oversee production. These individuals--practicing engineers, technicians, low-level managers¹--it is claimed, have to be guardians of society. They are thought to stand under a special--if not exclusive--moral obligation to protect society from the harms that could result from technological development. They must be ready and willing to risk their jobs and make other personal sacrifices in order to protect and promote public welfare.

This conception of engineers' moral responsibility is common not only in the public mind but among engineers themselves--at least in their public pronouncements. (Virtually every one of the many codes of ethics proposed by engineers gives paramount place to serving the public good.)² But does this conception of the moral responsibility of practicing engineers survive criticism? Given the nature of engineering activity and the nature of the organizations in which it is normally carried out, aren't these demands excessive, misplaced, and unrealistic? Why should engineers have to bear a special burden for the benefit of society? Indeed, can't it be argued that the nature of the corporate organization,³ with its specialization of labor and delegation of authority, insulates practicing engineers from moral responsibility? And, even if there is an ideal according to which engineers are guardians of society, isn't the suggested moral demand in fact unreasonable and impractical given the realities of corporate competition and job insecurity?

In this paper I shall defend a strong conception of the moral responsibility of practicing engineers and the others I have mentioned who are active in the creation and production of technology. I will argue that though engineers are bound by no special moral obligations,⁴ ordinary moral principles as they apply in the engineer's circumstances stipulate that they nonetheless be ready to make greater personal sacrifices than can normally be demanded of other individuals. Having made that argument I will defend it against common objections that seek to show that this demand is misplaced or unreasonable.

The "ordinary moral principles" stated in section II below are, I claim, quite general in scope, applying to anyone whose actions may contribute to harming others. However, to argue adequately for that claim would require a much longer paper. Instead, a few examples are provided as suggestive. The objections to the application of the principles, which I turn to in section III, are those most often heard in defense of or as excuses for questionable actions by engineers in corporations. These objections and the responses to them can, I think, easily be extended to cover the others mentioned above who are directly involved in developing and producing technological artifacts. I suspect, though, that further, often involved, arguments would be necessary to defend the principles in application to others in corporations (e.g., lawyers, accountants, janitors, secretaries), whose work is less directly related to technological production, and to professionals who are not in the corporation but hired by it for special purposes.⁵

Before turning to the arguments, I want to make perfectly clear just what sort of thesis I am arguing for. My thesis is that engineers have a strong moral obligation, where strength of obligation is to be understood in terms of the degree of personal sacrifice that can be demanded. I will say nothing, however, about how the public welfare is to be determined and little about the sorts of circumstances in which moral responsibility is to be exercised. These are quite different tasks from the one I have set and they require their own careful treatment.⁶ My main aim is just to establish that engineers must meet a high standard of moral performance. Detailed argument on the proper exercise of their moral responsibility awaits another occasion.

II

I begin from the assumption that, other things being equal, it is morally wrong to harm others. This principle is a feature of popular morality (e.g., it is a sentiment behind the Golden Rule) and of virtually all types of ethical theory--utilitarian, intuitionistic, contractarian, axiological, etc.--and I take it that no argument for it is necessary here.⁷ Somewhat more carefully stated, the principle--which I will call the Principle of Care--is this:

Other things being equal, one should exercise due care to avoid contributing to significantly harming others.

This principle has, of course, only *prima facie* force and is acceptable only with certain qualifications that would allow for legitimate competition, the voluntary assumption of risks, etc.

The "due care" clause of the principle designates such things as apprising oneself of the harm that may result from one's actions, taking precautions to avoid such harm, and being ready and willing to make sacrifices in order to reduce the likelihood of harm. One may think in terms of the responsibilities assumed in driving a car: one must recognize the dangers, attend to the driving, be skillful in controlling the car, and be willing to risk one's property and, to some extent, person in order to avoid injury to others.

The Principle of Care is stated in terms of contributing to harm rather than in terms of causing harm because, as I see it, we have a basic obligation to avoid playing any part in the production of harm: both to avoid playing a direct causal role and to avoid creating conditions from which harm can reasonably be expected to arise.⁸ Either sort of failure can result in culpability.⁹ Of particular importance in the present context is that moral obligation does not hold only of those who "make the decisions." More on this point later.

As the Principle of Care stands, it is vague. What counts as due care? When is harm significant? What are the relevant types of contribution to harm? A bit of the vagueness of the principle can be removed by noting that the degree of care due is a function of the magnitude of the harm threatened and of the centrality of one's role in the production of that harm. For example, the driver of a gasoline truck must be more attentive and have greater skill than an ordinary motorist. This is true for the simple reason that the truck driver is in a position to create greater harm than is the ordinary motorist. Similarly, journalists must exercise special care in their behavior because of the critical role they may play in the formation of the beliefs and attitudes of the public. The general rule here, a corollary to the Principle of Care, may be called the Corollary of Proportionate Care:

When one is in a position to contribute to greater harm or when one is in a position to play a more critical part in producing harm than is another person, one must exercise greater care to avoid so doing.

The consequences of the Principle of Care and the Corollary of Proportionate Care are, I think, easy to draw. Practicing engineers exercise considerable control over technological developments. Though they may not be the ones who decide which projects shall be worked on, they do design, test for quality and safety of, employ, and maintain technology. Their actions (or refusal to act) can greatly affect public welfare. And, given the nature of much technology, their work affects the public welfare, for better or worse, to a greater extent than do the activities of most other citizens. Managers and higher-level executives, of course, likewise affect the public welfare (through directing rather than creating and testing), and so they are similarly subject to this higher standard. Thus, by the Corollary of Proportionate Care, practicing engineers can be held to a higher standard of care; that is, it can be demanded that they be willing to make greater sacrifices than others for the sake of public welfare.

This higher standard against which engineers are to be judged does not require supererogation of them; it is merely the consequence of the ordinary moral requirements of care and proportionate care as they apply to the circumstances of engineers. However, since significant disincentives and obstacles will often stand in the way of meeting these ordinary moral requirements, engineers can expect to have to exhibit a certain degree of moral courage in the course of their everyday work. This does not mean that any and all demands on engineers to sacrifice their personal good for the public good are justified. But it does raise the standard for them.

These principles do not single out engineers. The same principles and conclusion hold for anyone in a position of power--power to harm--from truck driver to president. If one is not willing and able to make the sacrifices, then one should not seek or accept the position of power. To do so would be to act immorally.

III

Many objections can be raised against the application I have made of the Principle of Care and the Corollary of Proportionate Care to the circumstances of practicing engineers. For the rest of this paper I will consider several attempts to deflate engineers' responsibility or to shield them from it.

"I'd lose my job if I didn't." Criticized for acting immorally at his job--say, for falsifying a report on safety tests--an engineer might offer the excuse, "But I'd lose my job if I didn't. It's unfair to expect me to jeopardize my job." This response is just a version of the immemorial complaint that morality often conflicts with self-interest. The traditional reply is to point out that moral considerations are just the sort of things that override self-interest and that is that: it is time to exhibit moral courage.

Though I am arguing in this paper that engineers must be prepared to exhibit moral courage, I think the situation is a bit more complex than the traditional response allows. Two sorts of case must be distinguished. First is the case in which the engineer himself conceives the idea of falsifying the report in order to gain advantage for himself. It is to this sort of case that the traditional response most directly applies, and that, indeed, is all that needs to be said. The pursuit of personal gain (greed) is no excuse for wrongdoing.

But now consider the sort of case in which the initial impetus for falsifying the report comes from another person who has authority over the engineer. Taking the crudest case (from which the main point emerges most clearly), we can imagine the engineer's supervisor to have threatened to fire him if he doesn't sign the report. It is still wrong, and a breach of moral integrity, for the engineer to sign the false report, but, in the circumstances, he deserves sympathy, for he is in one sense a victim faced with having to make a sacrifice because of another person's immorality.

Now the question is, Should the engineer receive more than sympathy? Should he receive positive support of some kind from society? Why, the engineer may ask, must he alone and unsupported have to bear the burden of vigilance and sacrifice for society's sake? One answer is that he has entered and continues his employment voluntarily, full well knowing that his chosen job has certain benefits and certain liabilities. One of the liabilities is that his moral integrity will likely be put to the test. Recognizing this, he is free to choose not to take that particular job or not to embark on that sort of career. But if he does choose that employment, then the responsibility to bear the burden is solely his.

This answer is, I think, basically sound, but qualifications are necessary. For one thing, society needs the moral vigilance of individual practicing engineers. Government regulation, for example, does not replace it: regulations cannot be sufficiently detailed, flexible, or up to date; regulators who enforce the rules cannot be present to evaluate each significant decision. (And besides, what would insure that the regulators would apply the regulations conscientiously?) So, society needs moral engineers. How are moral engineers to be secured? Higher salaries may attract some, but, by and large, if it's moral engineers that we want, then we will have to make it possible to practice engineering morally, and this means providing support for engineers when moral action is difficult.

There is a further argument not only that society should provide support out of considerations of prudence, but that, at least at the present time, society owes support to engineers. This conclusion follows from the fact that society is not neutral in the choice to become an engineer. Young people are encouraged, formally and informally, to pursue professional careers such as engineering. Having entered a university engineering program--usually without the knowledge or ability for much mature reflection--students are channeled into a rigorous engineering curriculum that usually offers them little idea of what to expect on the job while extolling the virtues of the profession. Society takes advantage of immature decisions, fosters only limited development of reflective abilities, and provides only selective knowledge of what work will be like. In such circumstances it is difficult for aspiring engineers to gain an adequate appreciation of the moral pressures that they will encounter, and so they do not have a proper opportunity to judge whether they are willing to take on the responsibility that goes with the job. Understanding one's moral predicament comes, if ever, further down the line when more substantial career and life commitments have been made and there is much more to lose in changing employers or careers. This is not a fair position for a person to be placed in and is, in fact, likely to be most trying for the morally conscientious engineer. In this situation, then, society not only ought to provide support out of considerations of prudence, but also is morally bound to provide at least some degree of assistance.

I do not, however, want to overestimate the degree to which engineering students are misled about the moral demands of the jobs they are training for. They have some responsibility to ascertain the facts for themselves. Enough stories of spectacular corruption and the tragedies of unforeseen consequences have been publicized to provide a general awareness of the potential for moral problems. However, I still find startling the credulity of many of my engineering students and attribute it, to a significant extent, to the limited and exploitive education they often receive.

There are a number of mechanisms of support for engineers which society may provide. These include effective government regulation, legal remedies, and the activities of professional organizations willing to take strong measures, such as censure, boycott, and strike. It is not my purpose, however, to discuss these mechanisms at this time.¹⁰

I have claimed that engineers should be held to higher standards of care than others and argued that they should receive some measure of support from society in trying to meet those standards. To this I add the observation that not much effective support is presently available and there is not soon likely to be much more. This justifies sympathy for engineers in their predicament. It may even on occasion provide an excuse for certain sorts of complicity in wrongdoing. But it does not license total acquiescence to immorality. Nor do these allowances nullify the general requirement of a higher standard of care for engineers.

"If I don't do it, someone else will." Next, a very brief comment on the defense, "If I don't do it, someone else will."¹¹ Obviously, the fact that someone else will perform an immoral action if one declines does not make the action right. The defense could be couched in other terms: "Why should I have to be the one to sacrifice when the bad consequences are inevitable anyhow?" One answer is, of course, that moral integrity requires it. Another reply is to challenge the inevitability of the worst consequences. Generally, one may comply grudgingly while doing the best one can to temper the bad consequences and to combat further activities of the same sort (rather than to promote immoral practices through cheerful complicity). When some improvement can be effected, grudging compliance may be the morally best path, but at other times disengagement may be the only morally acceptable course of action.

It is possible that one may be the victim of bad moral luck and may keep finding oneself in situations that demand sacrifice, but there are things that one can do to reduce the chances. Some of these will be mentioned in the course of my reply to the next defense.

"It's not my job." This defense attempts to undercut the applicability of the principles I have stated. The claim here is that the engineer just does not have the power that I assert he has. According to this defense, the structure of corporations (as well as governments and other large hierarchical organizations) is such that people other than the practicing engineer make the critical decisions. Upper-level managers and executives are the ones who determine what projects shall be worked on, how work shall proceed, and what shall be done with the result. The engineer does not have and should not have discretionary power.¹² For example, engineers design an automobile within general guidelines that have been specified for them. The design they produce will have virtues and defects. They are responsible for pointing out the defects to the best of their abilities, but it is the managers and executives who decide whether or not to use the design and market the product. These individuals have control of technology, not the engineers.

The proper response to all this is to point out that discretionary power is not the only form of control. The harm that results from a dangerous product comes about not only through the decision to employ the design, but through the formulation and submission of the design in the first place. Harm could not come about if the engineers had refused to submit the design when they had good reason to believe that it was dangerous.

But now one might reply to this by acknowledging that the engineer does have the power to forestall harm, but then claiming that it is not the engineer's responsibility to exercise this power. Indeed, it would be wrong for him to do so. A corporation is structured so that people perform various limited and specialized functions, thus taking advantage of special talents and defining (supposedly) clear lines of authority and responsibility. Engineers are trained, hired, and paid to do engineering work. Their responsibilities and prerogatives extend no further.

In response, I will allow that corporations can (morally) be structured in this way. But allowing this still does not relieve engineers either from moral responsibility for harm that may result from their work or from the moral necessity of their taking appropriate action on the basis of that responsibility. When one gets into a position in which one abdicates or delegates control over choice of work, how that work shall be done, what shall be done with it, and so on, it is morally incumbent on one to have good reason to believe that control will be exercised morally. When there is reason to believe that those who exercise the powers one has relinquished are not to be trusted to act morally, then one has a responsibility to press for recognition of moral values, to withhold one's contribution, or to sever one's relationship altogether, depending on the gravity of the case. Indeed, even where one's work does not directly contribute to harmful results, one may be subject to moral criticism for indirectly supporting an immoral organization.

There is an important implication of this argument for the criteria by which one should evaluate prospective employment. In considering employment one must weigh not only economic and career opportunities, but also the morality of the organization and the prospects for moral action within it. One must consider the morality of the structure and goals of the organization and of the particular individuals involved--colleagues, supervisors, managers, and executives. One must also reckon on changes that are likely to occur. Selecting a job merely on the basis of personal preferences for salary, location, potential for advancement, or challenge and interest of the work leaves one completely open to moral criticism. And this process of moral evaluation does not end at the point of employment. Reevaluation of the potential for moral action in one's work is a continuing responsibility.

"There's no alternative." Pointing out the responsibility of engineers to judge the morality of the organizations they enter leads to the final attempt I will consider to defend an engineer's morally questionable activities. The defense is this. What if there is reason to believe that virtually any employment will place one in a morally compromising position? Such a circumstance does not necessarily mean that all potential employers are evil. The situation may rather be the result of structural deficiencies in the corporate form of organization or of the pressures of competition on vulnerable people who have insufficient support. In such a situation, what is even the most moral and well-intentioned engineer to do? Having prepared in good faith for a career in engineering, is he now required by morality to abandon that career?

The answer, I think, is yes. Of course, it is a matter of degree. But in the extreme case the conclusion is clear: if one's only alternative for an engineering career is to design fire bombs for the destruction of London, then it's time to try to emigrate or to change career. The point is that the degree of one's commitment and the good faith with which one has dedicated one's talents do not change the morality of the case. One may, perhaps, blame others for misleading one about the moral situation, but this does not alter what is the moral course of action.

There is one other option. This is to accept employment, but to maintain a crusading attitude. This alternative can be morally acceptable if one can hope to have good effects while not contributing to greater evils.

The general conclusion I hope to have established, however, is that moral considerations must always be borne in mind. Engineers, managers, and the others within the corporate structure who develop and manage technology are never mere "animate machines" in the service of corporate ends.¹³ Moral responsibility cannot be abdicated; corporate structure cannot shield one from responsibility as an autonomous moral agent.

NOTES

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1. For simplicity, I will usually refer hereafter only to (practicing) engineers and will consider specific objections with them primarily in mind.
2. A sample of codes of ethics in engineering can be found in Albert Flores, ed., *Ethical Problems in Engineering*, vol. 1, 2nd ed. (Troy, NY: Rensselaer Polytechnic Institute, Center for the Study of the Human Dimensions of Science and Technology, 1980), pp. 63-75.
3. Most engineers practicing in the United States work for private corporations. Similar arguments to the ones I give can be applied to the public sector. For a treatment of moral responsibility in government, see Dennis Thompson, "Moral Responsibility of Public Officials: The Problem of Many Hands," *American Political Science Review*, vol. 74 (1980), pp. 905-16.

4. In a sense that would constitute "strong role differentiation" as defined by Alan H. Goldman in The Moral Foundations of Professional Ethics (Totowa, NJ: Rowman and Littlefield, 1980), pp. 2-3.
5. Still further afield would be application of the principles to professionals (e.g., physicians, journalists) whose work is not in the development of technology.
6. Some of the main problems are raised crisply in Samuel Florman's Existential Pleasures of Engineering (New York: St. Martin's Press, 1976), chap. 3, especially pp. 21-22. I would not, however, endorse the solutions proposed there.
7. Readers unfamiliar with the philosophical literature may usefully consult The Encyclopedia of Philosophy (New York: Macmillan, 1967). See articles and bibliographies under such headings as "Golden Rule," "Problems of Ethics," "History of Ethics."
8. That other people's negligence or misconduct may be the critical factor through which harm results enormously complicates matters. I can offer only a brief comment. Take a case such as the illegal sale of hospital drugs by hospital personnel. Does this affect what a chemical engineer should do? To a certain extent the answer depends on the balance of good over evil that results from the engineer's work. True, other people are responsible for controlling illegal drug traffic, but, as I discuss below, morality requires that one consider and modify one's actions in light of the (fallible) workings of the whole system of which one is a part. In extreme cases, when great harm is likely to result, even though it be through other people's ignorance, negligence, or evil, one may have a moral responsibility not to continue. For example, I can see little moral justification for having any role in the rocketry work in Libya carried out by the German firm Otrag.
9. On culpability, see Kurt Baier, "Responsibility and Action," in The Nature of Human Action, ed. Myles Brand (Glenview, IL: Scott, Foresman, and Company, 1970), pp. 121-23.
10. A number of these mechanisms are discussed in Stephen H. Unger, Controlling Technology: Ethics and the Responsible Engineer (New York: Holt, Rinehart, and Winston, 1982), chap. 4, 5, and 6.
11. A number of perspectives on this defense in general are analyzed in the contributions of Jonathan Glover and M. Scott-Taggart to the symposium "It Makes No Difference Whether Or Not I Do It," Proceedings of the Aristotelian Society, suppl. vol. 49 (1975), pp. 171-209. See also section I of Michael Scriven, "Business Responsibilities in Product Design and Manufacture," in Responsibilities in Product Design and Manufacture: Proceedings of the Second Panel Discussion of the Council of Better Business Bureaus (Washington, DC: Council of Better Business Bureaus, 1978), pp. 92-103.

12. For a view of this sort, see Florman, especially chap. 3.
13. The "mechanical view" of corporate rationality is set out clearly in John Ladd, "Morality and the Ideal of Rationality in Formal Organizations," *Monist*, vol. 54 (1970), pp. 488-516. Ladd's article contains several useful references to the management literature on this topic.

Commentary

Andrew Oldenquist

This past summer, as I was boarding my DC-10 at Tokyo-Narita airport for the long flight to Kuala Lumpur, the smiling Japanese flight attendant said, "Have a nice fright." When I think of how many people, agencies, organizations, and companies are responsible for such frights (slight in my case, I admit), I cannot help but think that it is time the moral heat was taken off the engineers a little and distributed, without high indignation, among the many other places it also belongs.

Kenneth Alpern's thesis, that engineers are responsible for the foreseeable harm that may come from what they design, and to a degree proportionate to the gravity of the harm, is one with which I agree. There is no alternative to his conclusion that moral considerations must always be borne in mind, both in the appraisal of a design and before accepting employment. But I think he will make engineers resentful when he says they must be ready to "make greater personal sacrifices than can normally be demanded of other individuals," especially in the way he goes on about it later in his essay. It sounds, despite some disclaimers, as though engineers are singled out for potential martyrdom.

"I have claimed," he says, "that engineers should be held to higher standards of care than others, and argued that they should receive some measure of support from society in trying to meet those standards." Higher than we require of others in their own work? Why? The answer is in his Corollary of Proportionate Care: "When one is in a position to contribute to greater harm or when one is in a position to play a more critical part in producing harm, one must exercise greater care to avoid so doing."

Is a laborer less obliged to erect scaffolding safely and cover dangerous holes? A bus driver may find the schedule dangerously fast; a pilot may notice countless dangers his airline condones; mechanics may be asked to perform maintenance below minimum safety standards, workmen told to make concrete with what they know is too much sand, corporate financial officers asked to go along with practices likely to ruin the company and its stockholders, secretaries expected to be blind to their swindling or embezzling bosses, and so on. And on the other side, engineers do lots of work in their daily routines with about the same potential for Great Harm as the work of the average receptionist.

"These principles do not single out engineers. The same principles and conclusion holds for anyone in a position of power--power to harm--from truck driver to president." But the tone of the essay makes engineers sound singled out, because the author appears to underappreciate the moral responsibility as well as the power of "nonprofessionals," such as those listed above, to do harm.

I think engineers, physicians, and other professionals are somewhat more strongly obliged than ordinary workers to exhibit integrity, trust, and self-policing, for the reason that society has given those with the credentials exclusive and privileged access to a type of work, and hence stewardship over it. Laborers aren't in that situation. But surely the laborer or mechanic is as obliged as the engineer to make things that won't collapse or break down; there is, for example, no cogent argument I know that lower socioeconomic status justifies diminished responsibility. In any case Alpern doesn't make the distinction between these two kinds of obligations.

Alpern says job hunters should appraise the morality of prospective employers. I agree, but without enthusiasm except in extreme cases. One can be a moral snob about these things. You should not become the sorcerer's apprentice or work for the Mafia. But should you refuse an offer from McDonnell-Douglas because they have a bad record with one of their airplanes or from Dow Chemical Co. because they made napalm? Possibly Alpern does not have that in mind but means you should refuse employment where the job you would personally do is morally suspect. The latter would occur very rarely. I suspect most refusals to solicit or accept a job on "moral grounds" are motivated by politics or political ideology.

We usually respect people's "decisions of conscience" not to design whaling equipment or a highway through an Indian reservation, but we should not confuse these sentiments with plain obligations, devoid of ideals and ideology, not to build scaffolding that is likely to collapse or market a drug likely to cause birth defects. It is not that Alpern says the wrong thing about this. Rather, he doesn't say anything about it, and I would like to know a little more about my obligation to continuously monitor for moral defects the structure, colleagues, bosses, goals, and possible future changes in my company, beyond being told that it is a matter of degree but that I shouldn't design fire bombs destined for London. Engineers are told not to do or even contribute to harm, with no specifics; does this mean engineers are to avoid evil, in whatever sense each individual puts on it? And, since there is some evil in every large enterprise, decide for oneself if the degree of it warrants opting out? That would be a relief; but engineers will worry that if they admit the principle of nonparticipation in what is "evil enough," someone will emerge with a list, a catechism.

Morality ought to require small to moderate concessions of self-interest, shared nearly equally by all, and should be clearly seen to make each of us better off, in general, than we would be without the system. If morality is made too expensive, or if it is given an uncompromising, terrible

purity--a "though the heavens may fall" autonomy, a set of duties uninterested in human feedback--all but saints will reject it, and the rest of us will not call that morality. It is this tone of lofty, unyielding requirement that causes my only serious misgiving with the essay. And I am reasonably certain that if Alpern sat down and talked about cases and motives and human psychology, he would seem less like a marble statue.

But he says, "We have a basic obligation to avoid playing any part in the production of harm" [his emphasis]. This may require total withdrawal from organized society: no payment of taxes, for they buy instruments of death; no work for any corporation or government, for they all do some harm. Or may we sum the harm and good a government or corporation does, and collaborate if the result is positive (as he seems to suggest in a footnote)? We are not explicitly told. Finally, we are offered the hypothetical case in which "virtually any employment will place one in a morally compromising situation." Ought I then abandon my engineering career? Yes, he says. But the terrible abstractness of this puts it in the same pigeonhole with "do good and avoid evil." The interpretations range from a priggish "You will be cooperating with misleading advertisers and with a subcontractor who intentionally underbid" to "The whole economy is making gas for extermination camps and weapons for world conquest." The principle itself warrants scarcely a thought until we begin the discussion of interpretations.

Commentary

Samuel C. Florman

When speculating about engineering ethics, professional philosophers have a way of conjuring up situations that illustrate a point but are, for the most part, the stuff of fiction. Alpern speaks of an engineer falsifying a report on safety tests. Engineers do not falsify reports, nor are they asked by their employers to falsify reports. It is pure Hollywood to envision young, idealistic engineers wondering whether or not to blow the whistle on corrupt corporate executives who would compromise public safety by producing a dangerous car/plane/dam/bridge/chemical--pick your own scenario. Or, to be more precise, in the extremely rare instances when an engineer encounters bad people engaged in deceptive practices--and it will not happen once in a thousand careers--he knows that he must not participate. It is unprofessional, immoral, and probably illegal. What could be more obvious? And, once having been said, what could be more trite?

Engineers occasionally do things that are injurious to the public. This is not because engineers are immoral, but because they are sometimes inaccurate, careless, or inattentive. I will not quarrel with Alpern's Principle of Care or even his Corollary of Proportionate Care. But from these I would conclude that engineers, in their work, must be accurate, careful, and exceptionally attentive. The essence of engineering ethics, I believe, is reliability. Since people are counting on them, engineers should do their darnedest not to make mistakes.

But even if engineers are honest and sincere--which they almost invariably are--and careful--which they usually are--this does not help us determine which products, structures, and systems best serve the interests of society. Alpern is concerned with the question of how we use technology and protect ourselves from the potential ill effects of technology, and here in concentrating on engineering ethics he is very wide of the mark. We do not leave it to our soldiers to determine when we should have war or peace. Nor do we leave it to our judges to write our laws. Why, then, should we want our engineers to decide the uses to which we put our technology? Clearly we should not.

I was interested to see that in note 8 Alpern refers to rocketry work in Libya. It so happens that not long ago my company was invited to submit a bid on a building for the Libyan government in New York. As individuals--only incidentally as engineers--we did not care to work for a government that was said, among other things, to be assassinating

disenchanted emigres in various parts of the world. This gave us a moment of righteous self-satisfaction. But would society's best interests be served if all engineers refused to work for Libya, even if the United States government approved of the building in question? I respect engineers who do not wish to work on weaponry--I personally prefer not to--but do we want engineers, as a group, to decide whether or not the nation should be armed? Are we pleased when the longshoremen's union refuses to load the ships of some nation whose politics they dislike? What if Alpern succeeded in politicizing engineers only to see them support causes alien to his philosophy--like the engineers in Ayn Rand's *Atlas Shrugged* who withdraw from society, in effect going on strike, until the government agrees to abandon "liberal" programs? Certainly we do not want engineers--even morally superior engineers--to make decisions that we have not designated them to make.

Nor should we expect engineers to define the risks that society takes in connection with technology. We live in a democracy, not a technocratic oligarchy. We the people decide what sort of risks we are willing to take. We do it imperfectly and with a great deal of confusion and debate, but we do it nevertheless. We do it through laws and regulations. And where these do not pertain, we do it through standards of accountability that are established by juries comprised of ordinary citizens. Alpern says, "Harm could not come about if engineers refused to submit the design when they had good reason to believe that it was dangerous." This ignores the fact that all designs contain some element of danger. In seeking to minimize danger, one usually increases cost, and therein lies a dilemma. In our society, low cost of production is considered desirable because we believe that people of modest means should have access to as many material benefits as possible. In attempting to make a product absolutely foolproof--a ladder that won't tip, for example, or a no-scald shower valve--we add cost that the average citizen may not want to pay in order to compensate for the carelessness of his neighbor. There is no great trick to making an automobile that is as strong as a tank and safe to ride in. The challenge is to make an automobile that ordinary people can afford and is as safe as the community thinks it should be. There are also considerations of style, economy of use, and effect on the environment.

When engineers and managers get together to design a product, they have a host of criteria to consider. It is simplistic to depict this complex process as a fight between good and evil in which the bad guys try to maximize profit by compromising on safety. First of all, reductions in manufacturing cost do not serve to swell profits. Reductions in cost serve to reduce the selling price. Profit most often results when a product is considered by the public to be "good value," and debate will rage within corporate headquarters concerning how best to capture a market, that is, how best to attract and satisfy the public.

Where risk to the public is entailed, people of good will can differ widely about standards that should be applied. In my daily work I am involved in construction of buildings, and in my office you will find a dozen engineers--all good people--with different ideas about what constitutes a "safe" building--about materials, exits, alarms, stairs, sprinklers, wind

resistance, earthquake resistance, and on and on. Those who favor buildings that are less "safe" and more "economical" are not thinking of profit; they are thinking of conserved resources and affordable housing. I have heard hospital administrators decry safety requirements that they consider unnecessary--for example, a stair to be rebuilt six inches wider--arguing that costs added to health care put the entire community at higher risk.

Of course, all these individual opinions are beside the point because there are government standards and codes that determine what a safe building actually is. This is true, to the extent feasible, in all industries. It is the only process that makes sense.

There has been a steady growth of nationally accepted industrial standards--at present more than twenty thousand--and a proliferation of regulatory laws, agencies, and directives. This brings about complaints from people who wish that life were less complicated, but surveys show that this is the way that most citizens want to pursue. Regulations, codes, laws--made as sensible and streamlined as possible, but not at the cost of effectiveness--this is the best way to translate into action communal sentiments about technology.

Reliance upon the opinions--the bias!--of individual engineers, in industry puts control of our destiny in the wrong hands. It is also a recipe for chaos. If in a corporate setting each of several hundred engineers were to come to work each morning prepared to argue for his or her vision of an appropriately designed product, no constructive work could be accomplished.

Increasingly in large corporations, product safety has become the province of designated specialists. These people rely upon scientific knowledge and are guided by codes and regulations that have been established by other designated specialists--usually in the public sector. Where codes and regulations do not apply, then they must consider standards of liability as defined by law and the courts. These standards, of course, are constantly changing, reflecting, or let us say approximating, the public will. Insurance companies and their specialists also are part of the equation, sensitive to the mood and expectations of the community.

It is not a confession of moral weakness to stress a reliance upon law. Law is a communal expression of moral choice. In considering how best to deal with technological risk, it is not appropriate to stress the personal preferences of the individual engineer.

I agree with Alpern that "moral considerations must also be borne in mind" and that "moral responsibility cannot be abdicated." But the moral responsibility of the engineer, I maintain, is to do good, careful work within the parameters established by the community, not to be guided by personal whim.

By all means, let engineers not do work that their conscience forbids them to do. And of course, like all other law-abiding citizens, let them shun evil and report misdeeds to the proper authorities. Within limits of

conscience, however, each citizen may be called upon to participate in activities that he would rather see handled differently. We call this democracy.

By depicting technological design in terms of morality, Alpern does a disservice to his young students. They will find out soon enough, however, that engineering problems will not yield to good intentions. They will also find that many of their fellow citizens will blame technology for all sorts of ills while refusing to support the legislation, fund the agencies, or pay for the projects that would help cure these ills.

Ethical engineers, in addition to being careful, honest, and diligent in their work, will want to contribute time to the *pro bono* committees that set standards, investigate problems, and educate the public in technical matters. As citizens, they should also voice opinions and support causes in the political arena. These are better ways to do good, I believe, than undertaking the morally ambiguous role of vigilante in the workplace.