From *Educating the Ethical Professional: Proceedings of the Third Annual Laurier Conference on Business and Professional Ethics*. Oct. 23 & 23, 1998. Ed. Auleen Carson and John McCutcheon. Waterloo: Wilfred Laurier University, pp. 84–92.

Kent Peacock
Department of Philosophy
University of Lethbridge

Jan Shepherd
Faculty of Engineering Science
University of Western Ontario

KNOWLEDGE VERSUS OPINION: TWO MODELS OF PROFESSIONALISM[1]

Many years ago it was common for engineers and naval architects to literally risk their lives in order to demonstrate the safety of their work. We review ethical and epistemological grounds for this practice, and argue that it is consistent with the very high level of personal accountability that is integral to professionalism.

We introduce our problem by telling a true story. We take you back to a damp and chilly Monday morning in Portsmouth, England, in the year 1948. Neither the young naval architect, nor the Royal Navy NCO, nor the shipyard crew, really were all that enthusiastic about what they were about to do — although, as we shall see, the naval architect had reason to be remarkably *focused* on the task at hand. But no crowds would cheer, no flags would wave.

Upon the Camber, a venerable ramp of stonework that has been used to launch ships for centuries, sits a ship's hull. It is going to be launched broadside to the water. This is a hazardous procedure. The ship has been kept as light as possible and is therefore topheavy and very liable to roll right over if the slightest error has been made.

The naval architect has checked and rechecked his calculations, and personally inspected each rivet and weld. He can see no reason to think that the new hull will not perform as he designed it. He has claimed that it is ready for launch. And now he is going to prove that his claim is sincere in the most direct and unmistakable way: he is going to be on the bridge himself when that hull is unceremoniously dropped into the sea. No one else will be aboard; and he does not really need to be there in order for the vessel to be launched — the shore crew could easily do it themselves. Nevertheless, tradition deems it essential that he perform this (to our eyes) odd ritual.

Finally everything is ready. The blocks holding the hull are knocked out and it slides sideways into the water with a terrific slap, heeling over more than 60 degrees, dipping the port gunwale under, and kicking up a huge wave. If it is going to roll over, now is the time. But the hull rights itself and floats perfectly.

The vessel is brought to dockside and the young naval architect debarks. Papers are signed for the Royal Navy officer (since the Navy happened to be the client this morning), and the architect turns to other business. It is all in a day's work — although had something gone wrong, the naval architect would almost certainly have been killed, since there is essentially no hope of jumping out of the way of a 1000-ton ship if it turns turtle on top of you.

---

[1] We are indebted for many insights to Grant A. Whatmough, who was the young naval architect in our story.

If one were to look around Europe and the United Kingdom at the time of our story, one would find similar practices in other branches of engineering.

For example, the maiden spin-up of a new steam turbine can be a chancy matter. If a blade comes loose or some instability arises it can explode like a bomb. So what did they used to do? When the thing is ready for its first full-rpm test, everyone is at a very safe distance, behind concrete and bullet-proof glass — everyone, that is, except the design engineer, who is calmly sitting on the turbine casing.

Yet another example comes from bridge-building. There comes a critical moment at which the scaffolding is removed and the structure must stand on its own for the first time. Who would be sitting on a chair at mid-span when this was done? The designer, of course — after all, he did say that the bridge would hold up, didn't he?

In fact, disasters were remarkably rare. For reasons we shall explore here, this bit of apparently gratuitous showmanship was associated with a remarkably low failure rate. But there was not always a happy ending. One of our Engineering Ethics students told us of a grandfather who went to the bottom of the English Channel when the submarine he had designed did not float quite properly upon its launch. It was simply expected that the designer of a novel and important work of engineering should be prepared to literally risk his or her life to demonstrate that the work was sound. The designer really could be killed if something went wrong.

This practice went largely out of style not too long after the time of our story; and at first glance it does seem to be merely a sort of outmoded relic of medieval chivalry, an atavistic reversion to the days of mythic heroism and the "right stuff". But is it really? And can we learn some lessons about the nature of professionalism from this old tradition?

We have found, from teaching this bit of history in our Engineering Ethics courses and from discussing it with many people, that there tend to be strongly conflicting responses to it. Roughly, they are as follows:

Pro: the practice is excellent and should be revived, since the engineer demonstrates in the most direct and unquestionable way possible his or her willingness to take responsibility for the safety of his or her work. It is especially appropriate when the engineer is responsible for a novel design. The fact that the engineer will be risking life and limb in the process will give that engineer the strongest possible incentive to do the job right. Such practices will thus tend to produce a higher level of performance (in terms of reliability of novel design) than merely relying on "procedure". The practice also accords with the old ethical precept that one should not subject others to what one is not prepared to risk oneself.

Con: the practice is absurd and in fact immoral, since it is never proper to risk anyone's life. Furthermore, it encourages a sort of elitism that is not suited to today's corporate environment. It is mere grandstanding, with no practical value and considerable risk. Shipyard insurers could never be expected to accept this sort of risk; what if the deceased engineer's family sued? It would certainly not be necessary to ensure the highest possible level of performance, since proper design procedures, careful calculations, computer modeling, and obedience to appropriate safety rules and regulations will ensure safe design without the need to risk anyone's life. Meticulous attention to procedure, say these critics, is entirely sufficient to ensure safe design. Forcing professionals to risk their lives in this manner could discourage state of the art investigation by potentially making engineers too cautious to invent. Furthermore, isn't it just going too far? Hammurabi's code offered a slave for a slave, a son for a son, a life for a life. Is this a law of "fairness" and "appropriate" punishment? Perhaps what is appropriate in our society has changed. Surely it is better to disgrace someone in front of a jury of his peers and make him live through it than to kill him outright.

Note that among several issues that arise here there is an interesting clash of deontic intuitions. On the one hand, people may feel uneasy about risking a person's life simply to test a

piece of engineering; ships and turbines, after all, are replaceable, but individuals are not. On the other hand, people may feel that the engineer should be absolutely willing to do unto himself as he would do unto others. (Recent examples of professionals doing their utmost to evade responsibility for their actions, as in the Red Cross tainted blood scandal, might tend to intensify our feelings in this direction.)

In our paper we propose to examine these pros and cons in some detail, and we will come down (with some relatively minor qualifications) in favour of the old practice. Some objections to it are dealt with easily; for instance, the fact that the old practice engenders an individual authority for the engineer that clashes with managerial prerogatives could be a point in its favour, in those corporate atmospheres where the bottom line or the maintenance of managerial authority are placed above all other considerations. The ethical aspect is closer to the heart of the matter; we will insist that professionals must bear a burden of personal accountability that is in as direct a proportion as possible to their special authority and privileges. However, we will go a step further in our analysis, and argue that the issue is also *epistemological.*

Before getting into this, however, let us briefly review some basics of engineering ethics as it is specified and practiced in Canada. (Our references here are to the Ontario Code, but similar principles are set forth in all the provincial codes in this country.)

The first point to note is that the Code sets forth a totally unambiguous ordering of priorities for engineers. One's duty to public safety comes *first*, followed by duty to employers or clients, then by one's duty to other members of the profession, and finally one's duty to oneself. Thus, if an engineer found herself in a tricky situation in which (say) her employer, or another professional engineer, were doing something harmful to the public interest, her responsibilities would be very clear in spite of her natural reluctance to "blow the whistle" on a client or fellow professional. The APEO *Guideline to Professional Practice* states, "engineering is the only profession where the primary responsibility is to the third party, the 'public' in the true sense. Ultimately this overriding consideration subordinates the engineer's responsibility to the client (the second party)." (p. 4-5)

This kind of prioritizing makes a clear statement in favour of altruism, and, more important, for responsibility to everyone else — responsibility that cannot be set aside or contracted away. Throughout the Code and other defining documents there are frequent references to terms like "fairness," "loyalty," and "integrity." These terms are purposefully general, but in the realm of the average person's understanding. Nothing in the Code allows for looking for loopholes; instead, it insists that no matter the circumstance the engineer will strive for the highest of ideals. It is made very clear that the engineer is expected to understand and obey the *spirit* of the law, not merely its letter.

The engineer is a guardian and watchdog of public safety. The prime directive is that duty to public welfare is paramount. Public welfare is conceived of in increasingly broad terms: it includes concern for all members of the public in a wide range of priorities from personal safety to environmental safety (ultimately including the safety of the human race, not to mention every other living thing potentially). The very act of stating such high ideals sets a very high moral tone for the statute.

The harshest part of the Code concerns the engineer's duty to report: a practitioner shall "without fear or favour" (77-8) expose wrong-doing by employers or other members of the profession. Canada's codes of engineering ethics make it crystal clear that the engineer has a duty to report any wrong-doing or threat to public safety by his employers, his clients, and other professional engineers. Engineers cannot contract out of this duty, meaning that it overrides any specific employment agreement that an engineer may enter into.

Our students are often very uneasy about duty-to-report, since they know full well that blowing the whistle, no matter how morally commendable, could lead to loss of job, blacklisting throughout a whole industry, or even worse. Surely, they demand of us, there is some way to get

around this, some improved or finessed set of laws or regulations, or some sufficiently clever set of management techniques, that would render whistle-blowing obsolete.

There is no question that good management, adequate laws, and honest and tough enforcement of those laws can often prevent the situations that might make whistle-blowing necessary. But here we run right up against the hard epistemic problem that is the whole basis of the need for professional judgement. The human mind just does not have any way of predicting every significant event that might occur, of anticipating every contingency that might arise, or of managing every event so that there are never any nasty surprises or untoward risks. It just can't be done. So the professional will always be faced with the possibility of having to respond to a situation in which a perfectly sensible rule has been broken, or to a situation for which the rules have not yet been written.

This point was well understood by the authors of a brief but trenchant guideline entitled *A Professional Engineer's Duty to Report*, published by the Professional Engineers of Ontario.

> Engineers must act out of a sense of duty, with full knowledge of the effect of their actions, and accept responsibility for their judgement. For this reason any process which involves "leaking" information anonymously is discouraged. There is a basic difference between "leaking" information and "responsible disclosure." The former is essentially furtive and selfish ... the latter is open, personal, conducted with the interest of the public in mind and obviously requires that engineers *put their names on the action and sometimes their jobs on the line.* (APEO Guideline. The authors' names are not given, but this document certainly reflects the views of senior members of the engineering community.)

A few years ago we had a student who — when he was still an engineering technologist, before he went to university to get his degree — worked for a major company that was polluting its surroundings with radioactive waste. He first reported his concerns through proper channels, and was rebuffed. Finally he felt he had no choice but to take it to the newspapers, and eventually generated enough publicity that the company was embarrassed into taking some remedial action. However, he lost his job and was blacklisted in that particular branch of engineering. (Fortunately, he was able to find work in another field.) We had very little to teach this person about duty-to-report.

There is an important parallel between the situations of engineers and other professionals, and military personnel (especially officers). Officers get to wear a fancy uniform, and, at least in a well-run military, receive good pay and comfortable pensions, and enjoy special respect and prestige within their communities. However, in return for these benefits they may find it necessary to risk or even deliberately sacrifice their lives in the performance of their duties. No one could honestly promise a soldier that he would never be asked to risk his life in the performance of his duties. Similarly, no engineer could possibly be promised that he would never have to risk income, career, or life itself to do his duty. It just goes with the territory, and no one who is unwilling to accept such risks should go into the profession of engineering.

We hasten to add that an engineer's life is not necessarily sackcloth and ashes! Engineering has one of the lowest unemployment rates of any trade or profession, and engineers often enjoy very substantial pay and social prestige. Furthermore, engineers have certain legal privileges not open to the general public. There is a presumption of integrity which allows them to notarize documents and guarantee passports. More important, and more to the point, is that only registered professional engineers can authorize the carrying-out of certain kinds of engineering works — namely, those that have a potential impact on public or environmental safety, and which (because of their innovative or nonstandardizable nature) require the special judgement that an engineer is presumed to possess. The engineering profession is also allowed to be self-governing, meaning that engineers themselves decide who is to be permitted to become, and remain, an engineer. The whole point, however, is that these special benefits and privileges are given to the engineering profession *in return for* certain

expectations.

Let us return to the question with which we began. How shall we assess, in the context of engineering ethics, the old-fashioned practice according to which a naval architect was expected to be on board when his ship was dropped into the sea for the first time?

We readily concede that it may often be impracticable for a professional to do the equivalent of riding her ship down the ways. A surgeon cannot very well try a new surgical technique upon himself. Aircraft designers will not necessarily have the skills of test pilots as well. (Geoffrey de Havilland tried to test his own plane, with fatal results.) But heroism can take many forms; it may involve years of patient endurance rather than some flamboyant gesture. What is essential is captured by that phrase used by the APEO: the professional must be prepared, in whatever form it takes, to put career or life *on the line* in order to back up his or her work. *That's* what counts.

What about the objection to the old-fashioned practice which says that it is never proper to risk a person's life? The answer to this is that when we consider things like engineering works or buildings, there is no way to avoid the possibility of risk to life. Sooner or later, someone has to be the first person to fly that new airplane, and thus sooner or later someone will be at risk, regardless of how many "procedures" we implement. The only question, therefore, is who should be that first person, or those first persons, to face the risk — members of the public, or someone who bears professional responsibility.

There is also the question of informed consent. Only a professional (be it the designer, or a professional such as a test pilot whose business is to test new works) is truly able to give informed consent to the risks involved in testing a new engineering work. He or she will, or should, understand precisely how the work was constructed, how it is supposed to function, what the potentials risks are and why they exist. As the APEO observes, "The nature of professional services is such that the client is usually unable to define the services required and is unable to judge the quality and appropriateness of the service when received." (*Guideline to Professional Practice*, p. 6)

As noted above, the old-fashioned practice is obviously in accord with a long tradition of deontic thought, according to which a person should be willing to accept the risks to which he or she subjects others. People have attempted to justify this basic ethical intuition in a variety of ways. Kant, for instance, took it to be essentially definitive of any ethic, while it is also supported by many religious traditions. But one can argue that it has a harshly pragmatic or utilitarian basis as well, a basis that Thomas Hobbes would have understood and, we suspect, approved.

To see what this would be, ask why we accord special legal privileges to the professions such as engineering, architecture, and medicine. It is really very simple: human society frequently needs to have things done, such as building bridges, ships, and airplanes, which require a very high level of skill, creativity, and good judgement for their successful execution. It so happens that relatively few people have the requisite combination of abilities. Furthermore, in order to do their work effectively, these people must be given a lot of autonomy (and, of course, they must be well-rewarded for the unusual risks and efforts they undertake). Society simply cannot function unless these especially capable persons are given sufficient scope to exercise their abilities. No matter how democratic a society may wish itself to be, the basis for professionalism is unavoidably elitist in the sense we describe here.

But what is to prevent these specially-privileged persons from abusing their authority? Abuse of authority is one of the oldest and most persistent social problems faced by humanity, and no simple or universal cure has ever been found for it. The only trick that seems to work with any degree of reliability at all, is to devise some sort of traditions, laws, customs, or sets of habits that attempt to guarantee that those in authority are in some way *personally* responsible for the consequences of their actions. There can be many ways to do this, but the more directly, immediately, and promptly those consequences come back to their originator, the better such systems

seem to work. Those special persons who are given special privileges and authority *must* be subject to a level of risk that is somehow in proportion to their privileges, and to the effects their work can have on society. This is a point on which the Kantian and the Hobbesian will be in concurrence — the Kantian because this is just the way it should be, the Hobbesian because this is the most effective way to *make* the professional do the right thing.

On these grounds, the justification for the old-fashioned practice seems obvious. The naval architect who is expected to ride his own ship down the ways will have the strongest possible inducement to be as sure as anyone can be that the hull will perform. And as a consequence, society will benefit from the highest possible level of reliability. There are other mechanisms for enforcing responsibility, of course, such as peer review and public opinion, but the old-fashioned practice has a directness and intensity all its own.

We add another interesting historical footnote. Our young naval architect, in the British ship-building industry of 1948, *carried no professional liability insurance*. It was regarded as profoundly unprofessional for him to do so, since it would have been perceived as an attempt to evade personal responsibility. (Of course, it would now be regarded as unprofessional to *not* carry liability insurance, since otherwise one might have no way of compensating persons injured by one's mistakes.) It is beyond the scope of this paper to evaluate the merits of this old view, but it is an indication of how seriously the professionals of that time took the notion of personal accountability.

We mentioned that this question has an epistemic aspect as well. The only thing that can legitimize professional authority is the presumption of knowledge — we must be able to assume that the professional knows how to solve problems that we cannot solve ourselves. Hence in order to understand the basis of professionalism we have to be pretty clear about the nature of knowledge itself, one of the oldest — but still hotly debated — problems of philosophy.

In Plato's dialogue *Meno*, Socrates draws a sharp and very useful distinction between knowledge and what he calls "opinion" — our translation of a Greek term that means essentially "what people say." The *Meno* represents one of the first serious attempts to characterize the nature of knowledge, and it does not fully succeed — the account it gives is ambiguous, incomplete, occasionally fanciful, and even contradictory in important respects. But two important features of knowledge emerge: first, knowledge is something that is based upon understanding of the steps and principles involved, not merely parroting what others have said; second, you know something if you have worked it out *yourself*, gone through the steps, and traveled the road. Although Plato does not put it in exactly these terms, he presents a picture of knowledge as something that it is not primarily discursive, but instead intensely personal and performative.

You know the road to Larissa (a small town outside of Athens) if you can travel it, and have traveled it; you have opinion (perhaps right opinion, but still merely opinion) if you have merely been told the right road. (*Meno* 95-97) Right opinion is very useful, and is often all one has available. (For instance, by Socrates' standard, most of our "knowledge" of astronomy is opinion). But if you are in a situation where others are counting on you to do something that they cannot do, a situation where failure is not an option, then opinion is just not good enough.

This Socratic conception of knowledge is utterly at odds with a great deal of contemporary philosophizing about the nature of knowledge. For instance, Richard Rorty has gone to lengths to assert that all knowledge is merely a special kind of opinion, namely that which is dignified by the general concurrence of one's cultural community: the distinction between knowledge and opinion "is simply the distinction between topics on which such agreement is relatively easy to get and topics on which agreement is relatively hard to get." (Rorty, 1991, p. 23; quoted in Allen 1997, p. 188) And Theodore Roszak tells us, "An idea ... becomes knowledge when it gathers to itself a certain broad consensus in the society." (1994, p. 132)

The Socrates of the *Meno*, philosophical street fighter that he was, would have snorted in derision at these claims. And in fact, the engineering profession in Canada itself implicitly endorses

something like the Socratic conception — it sees knowledge as something that is based on an understanding (not merely a recitation) of principles, but most important, as something that is tested and proven in performance. You do not know how to build a bridge merely because someone, no matter how highly qualified, says you do; you know how to build a bridge if you have shown that you can do it. And that, of course, is not a matter of opinion; the bridge either stands up or it does not.

This points to the connection between epistemology and ethics: ethically, we demand that the engineer walk a mile in the shoes he himself has designed, but this is no more than the demand that he have secure knowledge, and not merely plausible opinion, about how those shoes will perform. If the Socrates of the *Meno* could be brought into our age, he would say that the designer who is genuinely prepared to go down the ways on his or her ship comes as close as one can come to being able to say, "I *know* this hull will float"; while the designer who relies solely on standards, regulations, computer models, calculations, etc., as reliable as these may have been in the past, still possesses only opinion. And it should not be opinion that the client pays for, or that the public relies upon!

(A comment on computer modeling, which was not available in 1948: it is an exceedingly useful tool, that greatly increases a designer's ability to anticipate the unexpected. However, any computer software is only as good as its logical architecture and the data that is input to it. It is necessarily built upon a structure of assumptions, and is, therefore, in the last analysis, just further opinion.)

What about the role of peer review? It is indispensable — but in the end it is still a form of opinion (although, of course, especially well founded and qualified opinion). Peer review cannot be the highest court of judgement on an engineer's work. It is, in the last analysis, Nature that will judge our works, and, as Richard Feynman remarked in his hard-hitting analysis of the Challenger disaster (a famous case in which certain key professionals were allowed to evade and fog their personal responsibilities), "Nature cannot be fooled." (Feynman, 1988, p. 237) Hence in order to assure the highest possible level of engineering performance, it is essential that we put as few political or procedural barriers as possible between our work and the opportunity to bring it directly to the court of Nature.

Louis Bucciarelli (1989) draws an interesting distinction between two styles of engineering. The True Believers, as Bucciarelli calls them, place all their faith in theory and in our ability to rationally plan ahead and anticipate all possible contingencies. In other words, the True Believer is a believer in opinion. Agnostics, on the other hand, are ironists and sceptics about theories, regulations, and planning methodologies; instead, they place their faith in Nature, or more precisely in the assumption that Nature *will* tell us if our designs are working well, if we pay careful enough attention.

> An Agnostic doesn't accept the absolute authority of abstraction, of number, of rules and of codes. Rational plans and procedures may help but they will not suffice...This breed of design practitioner relies heavily on tradition, on what worked last year, then presses further, strives to know the material thoroughly so as to be able to predict how the design will function in all circumstances. There is a negotiation process going on here — between the object and the designer. In this way the designer seeks to establish full control; there must be no surprises but that sense of control comes from a mastery of details, details not necessarily articulated as elements of a list or as quantities that sum. (1989, p. 206-207)

In other words, the Agnostic seeks the kind of performative knowledge that we have attempted to identify here. She is chronically skeptical of second-hand reports of the road to Larissa, no matter how good their credentials. Instead, she strives to know personally every twist and turn of that road herself. And we agree with Bucciarelli that this kind of engineering will tend to produce a much safer product in the long run.

What about the fear that imposing this extraordinary level of personal accountability could make professionals too cautious to innovate? We believe, on the contrary, that it will tend to encourage innovation. This is crucial, since the need for innovation is at the heart of professionalism. The APEO remarks that engineering "requires the exercise of trust, discretion, and judgement, and is not subject to 'standardization'." (*Guideline to Professional Practice,* p. 4) The term "judgement" is used roughly in the sense in which Aristotle used it; that is, it suggests an ability to arrive at a sound decision in the face of apparently conflicting priorities, or in the absence of some unambiguous algorithm. A professional is hired precisely because there is an important problem that does not have an off-the-shelf solution — a problem, in other words, that requires innovation. Engineering is often referred to as applied science, but this is not quite right, since engineering sometimes *leads* science. (The history of thermodynamics is a good case in point.) A number of important bridges, for instance, were referred to as "indeterminate" structures, meaning that at the time they were built they lacked a theoretical analysis. (Theory tends to catch up later on, of course.) This does not mean that the designer did not know what he was doing — it simply means that he could not, or could not be bothered, to rationalize what he was doing in terms of current theoretical *opinion.*

At base, therefore, professional engineering is *necessarily* innovative, and this gives rise to an apparent paradox, since there could seem to be a *prima facie* tension between the need to innovate and the conservatism that must come from the demand for safety and reliability. Engineers may, at times, find it needful to work to the limits of known scientific principles. Hence, in one sense, engineering can be as exploratory and experimental as so-called pure science. However, there is a crucial difference between engineering and "pure" science, namely that in engineering failure cannot be tolerated. A pure scientist may learn something useful from an experiment that fails, but an engineer does not have this luxury. The client and public are depending upon the engineer to get it right, even if it is something that has never quite been done before.

There is no glib way to describe a resolution to this paradox, since to ask for that would be equivalent to asking for a succinct statement of the secrets of good engineering design itself. Perhaps we could provide a partial answer by suggesting that there is a conservatism based on opinion, and a conservatism based on knowledge. The designer who permits himself to be guided exclusively by opinion is more likely to be the one who will be too cautious. This will happen because opinion naturally tends to be conservative, but in a way that is *not* based on understanding. Conservative opinion often resembles nothing so much as a set of taboos, prohibitions based on fear of the unknown. Our young naval architect, on the other hand, would have certainly argued that from his point of view what he did that damp Monday morning was entirely conservative, but based upon his very firm *personal* understanding of how his ship's hull would behave. It may have looked risky to others, but they were not in possession of the naval architect's epistemic privilege. In fact, he was not taking much of a risk at all. He *knew* that what he was asking that hull to do was well within its safety limits.

Knowledge-based engineering will therefore tend to be safer, and this will make innovation more feasible. Conversely, the higher level of failure that would be associated with opinion-based engineering would tend to sour clients, investors, and society in general on the risks of innovation. (See Shute, 1954, for a fascinating and sobering account of the difference between knowledge-based and opinion-based engineering, and the devastating consequences for a whole industry when the latter led to a spectacular failure.)

The Codes of Engineering Ethics in Canada are a result of a historical process. They were literally constructed by engineers themselves. As Christopher C. Hart emphasized (1978), they are not merely a public relations gesture — although they do support public recognition of engineering as a profession — but part of the working conceptual apparatus of the engineer. Their main purpose is to provide a sort of checklist so that the working engineer can make sure that she has done the right thing. This checklist was, itself, engineered so that it would work as effectively as possible.

The central emphasis on good character and integrity reflect a recognition of the professional engineer's epistemic privilege, a privilege that would be instantly subverted if the engineer ever fails to tell or acknowledge the truth.

The engineering ethic is always evolving, as the needs of society change and as engineers come to recognize wider concerns. The recently-adopted Environmental Guidelines (PEO, 1994) are an important demonstration of the flexibility and organic nature of the profession's conception of its responsibilities.

The very structure of the Code of ethics implies a drive to innovate. It says that you can't just be one of those opinion-based conservative designers who enjoy the comforting illusion of safety. For engineers to continue to be useful to society, and for them to continue to enjoy their special privileges, they must be prepared to take on the new problems (especially the increasingly important environmental problems) that society faces all the time. The Code does not merely encourage innovation — through its provisions which call for sharing of knowledge among professionals, maintenance of professional competence, and public education — it *compels* engineers to innovate by pushing them to be the best possible engineers they can be.

An essential part of this push to excellence is the emphasis on personal accountability, which says that good intentions are not good enough, that second best is not good enough, that error and wrong-doing will reflect back on their originators in the most immediate and personal way. The highest possible level of personal accountability, as exemplified by our naval architect on that Monday morning long ago, is not merely a way to glorify Engineering Practice to the status of a "profession", but can be a driving force behind new and innovative (but safe) engineering.

References

Allen, Barry, *Knowledge and Civilization.* Ms. in preparation, 1997.

Association of Professional Engineers of Ontario (APEO), *A Professional Engineer's Duty to Report: Responsible Disclosure of Conditions Affecting Public Safety.* Toronto: APEO, no date given.

Association of Professional Engineers of Ontario (APEO), *Guideline to Professional Practice.* Toronto: APEO, no date given.

Bucciarelli, Louis L., "Is Idiot-Proof Safe Enough?", *Ethics and Risk Management in Engineering*, Albert Flores (ed.). Lanham: University Press of America, 1989, 201-209.

Feynman, Richard P., "Personal Observations on the Reliability of the Shuttle," in *What Do* You *Care What Other People Think?* New York & London: W. W. Norton, 1988.

Hart, Christopher C., "A Recitation of the Principles," *Canadian Consulting Engineer*, March 1978.

Plato, *Meno.* Tr. W. H. D. Rouse, *Great Dialogues of Plato.* New York: New American Library, 1956.

Professional Engineers of Ontario (PEO), *Environmental Guidelines for the Practice of Professional Engineering in Ontario.* Toronto: PEO, 1994.

Rorty, Richard, *Objectivity, Relativism, and Truth: Philosophical Papers.* Vol. I. Cambridge: Cambridge University Press, 1991.

Roszak, Theodore, *The Cult of Information.* Second Edition. Berkeley: University of California Press, 1994.

Shute, Nevil, *Slide Rule.* New York: Wm. Morrow & Co., 1954.