Techné: Research in Philosophy and Technology

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Special Issue: Research in Ethics and Engineering

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Research in Ethics and Engineering

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Introduction

Engineering ethics has only recently started to take off as a research discipline. Whereas in the US ethics-textbooks for the education of engineers have seen the light from the 1970s onwards, there have been very few research efforts in the field. This is all the more surprising if one compares engineering ethics with bioethics, which has developed into a booming field of research. It seems obvious that engineering and technology pose at least as many pressing and interesting ethical questions as medicine and biotechnology.

Fortunately, recently there are more and more initiatives for advanced efforts on engineering ethics. In the Netherlands, all the three Universities of technology (Delft, Eindhoven and Twente) have developed substantial philosophy departments in the last years that do research in the philosophy of technology, with groups that are specialized in engineering ethics. In the spring of 2002, the ethics group of the Philosophy Department of Delft University of Technology organized a conference on "Research in Ethics and Engineering". Participants came from various parts of the world: Europe, the US and Asia. The conference was organized around three themes: risk, autonomy and engineering as a profession.

Some of the contributions to this conference can now be read in this special issue of *Techné*. In this editorial we will discuss some common themes that can be identified in the various contributions. We will also try to clarify where discussions in this field might be related to mainstream moral philosophical issues. Our aim is to highlight topics that might be the focus for future research in the field of engineering ethics.

Social Arrangements for Decision-Making about Technology

When thinking about how the benefits of technology to mankind may be maximized, one could try to evaluate particular actions or developments, but one might also take the view that what needs to be evaluated are the social arrangements for decision-making about technology. The latter view might be characterized as procedural: the idea is, roughly, that if decision procedures are morally sound, then the decisions that result from these procedures will generally be sound as well. This approach is found in the contributions of Richard Devon and Yannick Julliard.

Richard Devon's aim is to generate, from the context of technology, research questions aimed at improving (the systematic study of) social arrangements for decision-making. He argues that the quality of social arrangements for decision-making (about technology) to a large extent determines the ethical acceptability of the outcomes of such decision-making. Therefore such social arrangements are a worthwhile object of study for philosophical ethics. So, whereas the traditional focus of ethics is on the right action, the focus of social ethics is on the right social process. For technology, according to Devon, this means focusing on the design process and on project management. He emphasizes two central values in the social ethics of technology: *cognizance* and *inclusion*. Cognizance is to be understood as understanding, as well as possible, the implications of technology: "its possible uses and its social and environmental impacts in extraction, production, use, and disposal". Inclusion means: "making sure the right people are included in the decision making." As Devon remarks, inclusion also improves (but does not ensure) cognizance.

Devon argues rather convincingly that what he calls "social ethics" would be a fruitful field of study—by showing, e.g., that many famous engineering ethics case studies are more suitably conceptualized as problems in social ethics rather than individual ethics. He also speculates on what insights might be achieved by practicing a social ethics of technology. His contribution is mostly programmatic in character. It is to be hoped that researchers in this area acknowledge the importance of this approach and develop a methodology and formulate research questions. Some researchers have of course already started doing this (see Herkert 2003; & Devon & van de Poel 2004).

The contribution of Yannick Julliard fits squarely within the approach proposed by Devon. Julliard advances a system of Ethics Quality Management (EQM), inspired by Total Quality Management as laid down in the ISO 9001 norm. The intention of Julliard's approach is to ensure ethical behavior of companies involved with technology—but presumably, any type of company—by creating procedures that force all individuals within a company to somehow act in line with the needs of society. The author intends his contribution as a first step on the way of giving ethics within companies a very concrete focus, by means of a system of norms that has proven its success in other areas.

In fact, what EQM is aiming to achieve is successful "inculturation" of technology: "the task of ethics quality management is to focus on the acceptability of technology and products as a central value" (Julliard (this issue) p.6). However, there could be a gap between *acceptability* and *acceptance*. A technology or product could be, as a matter of fact, accepted by customers or even society at large, while nonetheless being unacceptable from a more Archimedean point of view, for example because of considerations related to sustainability. It is not hard to think of actual products where this is the case. EQM would appear to be at least in danger of emphasizing acceptance at the cost of acceptability considerations. This worry arises as a result of the emphasis on conflict solving between the involved parties, and the praise for EQM as a way to reduce economic risks of companies. If ethics is conceived of as some kind of marketing strategy, do we thereby achieve the disinterestedness and long-term view that would seem to be the trademarks of ethics proper?

A general worry about the procedural approach, which can be found in discussions of the work of Jürgen Habermas and of John Rawls, remains: how can a procedural approach guarantee the quality of its outcomes? That is, can we trust that if the right procedures are in place, all ethical problems will be properly dealt with? One should probably conclude that a procedural approach in this sense is not sufficient on its own. Devon's point that social engineering ethics should be a topic of academic study alongside the traditional individual approach is of course not affected by this. However, it may be a legitimate worry in fleshing out Julliard's EQM approach.

In a rather different way, Hansson's contribution also addresses social arrangements for decision-making about technology. However, rather than reflecting on the procedure, he comes up with a substantial moral condition that collective decisions which lead to the imposition of (technological) risk would have to satisfy: "Nobody should be exposed to a risk unless it is part of an equitable social system for risk-taking that works to her advantage." It would be interesting to think about whether, and if so how, a decision-making procedure could be designed which would ensure fulfillment of this condition.

(Cultural) Context of Engineering Ethics, and Differences in Approach

To what extent does and should the context within which an ethics was developed determine the central norms, and also the focus on certain types of problems and their approach? Two contributions to this issue, in rather different ways, are concerned with this question.

Heinz C. Luegenbiehl considers the notion of autonomy, which is central to Western engineering ethics. Is an engineering ethics that is centered on this notion also applicable in other parts of the world? No, is the answer that Luegenbiehl gives in his article “Ethical Autonomy and Engineering in a Cross-Cultural Context.” By discussing the case of Japan, he shows that in some cultures autonomy does not play a central role. Luegenbiehl contrasts American society with Japanese society. Japan is a culture with an emphasis on the group above the individual. Hence, there is little space for professional autonomy. Rather, in Japan we see the practice of collective responsibility. The head of a company resigns instead of the person who made a mistake. It is not the profession but the corporation that is responsible for the well being of the society. Nevertheless, in the Japanese context we can still make use of important insights from “standard” engineering ethics by distinguishing between the value of autonomy and the goal that autonomy has to achieve (“safety, health and welfare of the public”). This means that certain ideas will need to be rephrased and the emphasis has to shift from the individual to the group. So even though there are important cultural differences, as this case shows, a global engineering ethics is still possible according to Luegenbiehl.

Another type of difference in context that is relevant to how a body of ethics has developed has to do not with regional or cultural differences, but with differences between disciplines. Joe Herkert and Brian O’Connell, in their contribution “Engineering Ethics and Computer Ethics: Twins Separated at Birth?”, observe that engineering ethics and computer ethics have developed along parallel, but separate paths. In part this appears to be due simply to the fact that different individuals contributed to the two topics; however, it may also be due to the fact that engineering and computing have significant differences in their development. Whereas the former is traditionally focused on “transformation of the physical world,” the latter is in first instance grounded in abstraction. The resulting difference between engineering ethics and computer ethics is that the former is much more grounded in a robust, everyday practice, whereas computer ethics is more abstract. O’Connell and Herkert argue that computer ethics should adopt this practical attitude as well. On the other hand, computer ethics can serve as a model on how to integrate micro-ethical and macro-ethical approaches. The former focus on individual agents, the latter on social institutions. Traditional engineering ethics has had a hard time integrating both approaches. Computer ethics is more advanced in this respect.

Apart from the fact that computer ethics and engineering ethics can learn important lessons from each other, the authors point out that there is another obvious reason why the two branches of ethics they consider should not remain separated. Many important moral issues in information technology have implications for other areas of engineering as well, since computers permeate many areas of engineering. A lot of engineering nowadays is simply unthinkable without the use of computers. Issues such as privacy and computer system reliability are therefore not only relevant to computer ethics but also to engineering ethics. O'Connell and Herkert mention the case of the Therac 25 as an example of this.

It is interesting to note that whereas Luegenbiehl is mostly cautious about how insights in American engineering ethics can be applied elsewhere, O'Connell and Herkert enthusiastically argue that it's time that computer ethics and engineering ethics integrate more and start learning from each other. Perhaps discipline-related differences in context are easier to overcome than cultural ones. There is another difference between the two cases that may explain this: whereas the different disciplines have led to concern with very different types of issues, and therefore advances in different areas, the cultural difference shows that the norms that have been developed may need to be readjusted, by trying to discern a more universal underlying norm. However, in both cases the ethics originally developed in different contexts more and more permeate each other, and therefore there is little choice but to attempt to somehow find ways to integrate them.

Practical/Professional versus Abstract/Applied Approach

A common theme that can be identified among various authors is the question whether engineering ethics should start from general, abstract principles that should be applied to particular cases or whether it should start from the concrete professional practice of engineers. This discussion relates to a discussion that is lead in general moral philosophy. Philosophers who adopt a Kantian approach think that ethical reflection should start with general, abstract principles. Aristotelians instead emphasize the role of concrete experiences, practices and (moral) perception of particular cases. Utilitarians (at least act-utilitarians) as it were choose a middle ground: the utilitarian principle is general and abstract, but action prescriptions depend on concrete circumstances. With the authors who contributed to this special issue, we see various positions being taken: Whitbeck defends a practical, Aristotelian approach, Luegenbiehl and Herkert/O'Connell can be seen as authors who emphasize the role of particular contexts but still think that formulation of general moral insights is possible, whereas Hansson discusses various general moral principles and defends one specific general moral principle.

In her paper "Investigating Professional Responsibility," Caroline Whitbeck distinguishes between two philosophical approaches to the topic of professional responsibility, namely "applied ethics" versus "practical ethics." "Applied ethics" refers to approaches that start from a general ethical theory that can be applied to concrete cases. However, as has been argued by intuitionists such as W.D. Ross, Aristotelians, Wittgensteinians and feminist philosophers, the moral landscape is too complex and diverse to allow for such a generalistic top-down approach. These philosophers all advocate an alternative approach. Moral deliberation and reflection has to be bottom-up: starting with the particular facts of a concrete case and forming moral judgments based on these particular cases. This is the kind of approach that Whitbeck defends.

Whitbeck concludes that philosophers working in professional ethics should adopt the practical ethics-approach: on the one hand providing the professions with arguments, ideas and concepts from moral philosophy, on the other hand learning from the vast experience from the professions and interacting with social scientists and other scholars in the humanities.

Various other authors address the issue of an abstract versus a practical approach more or less explicitly. As said before, according to O'Connell and Herkert, a major difference between engineering ethics and computer ethics is that the former is more practical, the latter more theoretical, and they think that both approaches can be fruitfully combined. Heinz Luegenbiehl's contribution can be read as a more practical approach to engineering ethics. However, Luegenbiehl argues that despite the enormous differences between the American and the Japanese approach, a global engineering ethics is still possible. As mentioned in section 3, this can be done by focusing on the goals we want to achieve with technology instead of on how to achieve them, which can differ from culture to culture.

Sven Ove Hansson thinks that general moral theories can be challenged by cases involving technological risks. He argues that standard ethical theories are ill suited to deal with indeterministic cases. He advocates a closer collaboration between moral philosophy and decision theory, especially concerning ethical aspects of risks. Furthermore, standard approaches to risk analysis, which are based on utilitarian calculus, inherit all the well-known problems of utilitarianism such as the possibility that minorities have to suffer in order that a majority gets certain advantages. This leads Hansson to formulate the general principle mentioned before: "Nobody should be exposed to a risk unless it is part of an equitable social system for risk-taking that works to her advantage." Hansson concludes that moral philosophy has a lot to contribute to the fields of risk analysis and risk management, but that at the same time the topic of risk raises some challenging issues that require new philosophical approaches.

These articles all put a different emphasis on abstract or practical approaches. However, rather than posing mutually exclusive alternatives between which we are forced to choose, it might be possible to learn something from all these various arguments. Note that even Hansson's general principle explicitly mentions particular circumstances, i.e. concerning an "equitable social system...that works to her advantage." This leaves open various different social arrangements and doesn't prescribe in advance what kind of social system might fulfill these conditions. Still Hansson's contribution shows why it is worthwhile to try to formulate the conditions for such a system in a general way. This way we can make some general comparisons between alternative guidelines for acceptable risks. Luegenbiehl thinks that the concept of autonomy might be too much tied to a cultural context to be worthwhile for a global engineering ethics, but he thinks that the goals of technology can be formulated in a general and universal way. O'Connell and Herkert think that computer ethics and engineering ethics can contribute a lot to each other, exactly because the former is more general and abstract and the latter more practical and concrete. Whitbeck emphasizes the experience professionals have and which cannot be replaced by general and abstract ideas. The professional does not only have technical experience but also moral experience inherent to his or her work, experience that cannot be adequately replaced by abstract, general philosophical ideas.

The conclusion we can draw from these interesting arguments is that the role of general reflection can be to discern general patterns and formulate criteria for comparability, while this can never replace concrete, practical moral judgments in particular circumstances. General reflection can only be an aid in reflection, but not an absolute guide, since concrete moral reality is much too diverse and too complex to allow for this. People who work in practical contexts have an expertise and practical wisdom that can be assisted, but not replaced by, general moral reflection. Moral philosophers who work in engineering ethics should also consider concrete, particular cases and listen to the experience of professionals and include this in their normative assessment.

Professional Values Across Different Professions

If the approach taken in engineering ethics is predominantly an approach in which we try to distill values from professional practice, rather than applying abstract principles to that practice, then supposedly we should expect differences between the ethics of different practices. Caroline Whitbeck gives several examples of this. For example, whereas in engineering there is a prohibition on taking work outside one's competence, there is no such prohibition in medicine. This is because medical education is generally such that trainees necessarily have to perform procedures on patients in real life situations in order to aqcuire the skills needed for their future work, whereas engineers can aquire the required knowledge in a theoretical setting. In medicine, on the other hand, there is a strong obligation not to cease medical help to a patient, whereas in engineering there is generally no such rule. Probably this is connected with the fact that a medical patient finds himself in a much more vulnerable and dependent position than an engineer's client. Another example may be found in a comparison of legal professions with engineering: solicitors should at all times avoid conflicts of interest, whereas engineers "merely" have to find a way of dealing with such conflicts openly and fairly.

But also when we take a more abstract approach to ethics, as outlined in the previous section, there may be interesting differences between professional values. Luegenbiehl observes that in the American approach to engineering ethics, there is an increasing responsibility for the professional, this in contrast to other professions that move away from paternalism to more individual responsibilities of clients or users. In medicine, for example, the focus is much more on patient autonomy, as may be seen from the importance of the principle of informed consent. According to Luegenbiehl, this is because technology is increasingly complex. Engineers possess specialist knowledge that enables them to make responsible decisions, whereas the general public lacks the necessary knowledge to understand the technology.

Interestingly, Luegenbiehl appears to think of this move towards paternalism as a necessary feature of professionalization. This gives rise to the puzzling question whether technology is indeed so much more complex than medicine, where increased professionalization led to a move away from paternalism. The issue is in fact controversial within engineering ethics, for whereas Luegenbiehl is without a doubt giving a correct description of the status of client autonomy in the engineering profession, other authors (such as Martin & Schinzinger 1996; Robert Baum 1983) call this norm into question.

Conclusion

There are many interesting and pressing ethical topics that engineering and technology give rise to. This special issue features authors who all make an effort in identifying problems and offering possible solutions. The authors have various backgrounds: moral philosophers, philosophers of science and engineers who have devoted research on ethical aspects of their work. The basis is there for an interdisciplinary, international research community.

Hopefully this special issue will spark further discussions and research in this important and interesting field.

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Philosophical Perspectives on Risk

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The Concept of Risk

In non-technical contexts, the word “risk” refers, often rather vaguely, to situations in which it is possible but not certain that some undesirable event will occur. In technical contexts, the word has many uses and specialized meanings. The most common ones are the following:

(1) risk = an unwanted event which may or may not occur.
(2) risk = the cause of an unwanted event which may or may not occur.
(3) risk = the probability of an unwanted event which may or may not occur.
(4) risk = the statistical expectation value of unwanted events which may or may not occur.
(5) risk = the fact that a decision is made under conditions of known probabilities (“decision under risk”)

Examples: Lung cancer is one of the major risks (1) that affect smokers. Smoking also causes other diseases, and it is by far the most important health risk (2) in industrialized countries. There is evidence that the risk (3) of having one’s life shortened by smoking is as high as 50%. The total risk (4) from smoking is higher than that from any other cause that has been analyzed by risk analysts. The probabilities of various smoking-related diseases are so well-known that a decision whether or not to smoke can be classified as a decision under risk (5).

The third and fourth of these meanings are the ones most commonly used by engineers. The fourth, in particular, is the standard meaning of “risk” in professional risk analysis. In that discipline, “risk” often denotes a numerical representation of severity, that is obtained by multiplying the probability of an unwanted event with a measure of its disvalue (negative value). When, for instance, the risks associated with nuclear energy are compared in numerical terms to those of fossil fuels, “risk” is usually taken in this sense. Indeed, all the major variants of technological risk analysis are based on one and the same formal model of risk, namely *objectivist expected utility*, that combines objectivist probabilities with objectivist utilities (Hansson 1993). By an objectivist probability is meant a probability that is interpreted as an objective frequency or propensity, and thus not (merely) as a degree of belief. Similarly, a utility assignment is objectivist if it is interpreted as (a linear function of) some objective quantity.

It is often taken for granted that this sense of risk is the only one that we need. In studies of "risk perception," the "subjective risk" reported by the subjects is compared to the "objective risk," which is identified with the value obtained in this way. However, from a philosophical point of view it is far from obvious that this model of risk captures all that is essential. I will try to show why it is insufficient and how it should be supplemented. In doing this, I will also show how the issue of risk gives rise to important new problems for several areas of philosophy, such as epistemology, philosophy of science, decision theory and—in particular—ethics. Let us begin with epistemology.

Epistemology

In all the senses of "risk" referred to above, the use of this term is based on a subtle combination of knowledge and uncertainty. When there is a risk, there must be something that is unknown or has an unknown outcome; hence there must be uncertainty. But for this uncertainty to constitute a risk for us, something must be known about it. This combination of knowledge and lack thereof contributes to making issues of risk so difficult to come to grips with in practical technological applications. It also gives rise to important philosophical issues for the theory of knowledge.

Risk and Uncertainty

In decision theory, lack of knowledge is divided into the two major categories "risk" and "uncertainty". In decision-making under risk, we know what the possible outcomes are and what are their probabilities.[1] Perhaps a more adequate term for this would be "decision-making under known probabilities". In decision-making under uncertainty, probabilities are either not known at all or only known with insufficient precision.[2]

Only very rarely are probabilities known with certainty. Therefore, strictly speaking, the only clear-cut cases of "risk" (known probabilities) seem to be idealized textbook cases that refer to devices such as dice or coins that are supposed to be known with certainty to be fair. More typical real-life cases are characterized by (epistemic) uncertainty that does not, primarily, come with exact probabilities. Hence, almost all decisions are decisions "under uncertainty". To the extent that we make decisions "under risk," this does not mean that these decisions are made under conditions of completely known probabilities. Rather, it means that we have chosen to simplify our description of these decision problems by treating them as cases of known probabilities.

It is common to treat cases where experts have provided exact probabilities as cases of decision-making under risk. And of course, to give just one example, if you are absolutely certain that current estimates of the effects of low-dose radiation are accurate, then decision-making referring to such exposure may be decision-making under risk. However, if you are less than fully convinced, then this too is a case of decision-making under uncertainty. Experts are known to have made mistakes, and a rational decision-maker should take into account the possibility that this may happen again. Experts often do not realize that for the non-expert, the possibility of the experts being wrong may very well be a dominant part of the risk (in the informal sense of the word) involved e.g. in the use of a complex technology. When there is a wide divergence between the views of experts and those of the public, this is certainly a sign of failure in the social system for division of intellectual labor, but it does not necessarily follow that this failure is located within the minds of the non-experts who distrust the experts. It cannot be a criterion of rationality that one takes experts for infallible. Therefore, even when experts talk about risk, and give exact probability statements, the real issue for most of us may nevertheless be one of epistemic uncertainty.

The Reduction of Uncertainty

One possible approach to all this epistemic uncertainty, and perhaps at first hand the most attractive one, is that we should always take all uncertainty that there is into account, and that all decisions should be treated as decisions under epistemic uncertainty. However, attractive though this approach may seem, it is not in practice feasible, since human cognitive powers are insufficient to handle such a mass of unsettled issues. In order to grasp complex situations, we therefore reduce the prevailing epistemic uncertainty to probabilities ("There is a 90% chance that it will rain tomorrow") or even to full beliefs ("It will rain tomorrow").[3] This process of uncertainty-reduction, or "fixation of belief" (Peirce 1934), helps us to achieve a cognitively manageable representation of the world, and thus increases our competence and efficiency as decision-makers.

Another possible approach to uncertainty is provided by Bayesian decision theory. According to the Bayesian ideal of rationality, all statements about the world should have a definite probability value assigned to them. Non-logical propositions should never be fully believed, but only assigned high probabilities. Hence, epistemic uncertainty is always reduced to probability, but never to full belief. The resulting belief system is a complex web of interconnected probability statements (Jeffrey 1956).

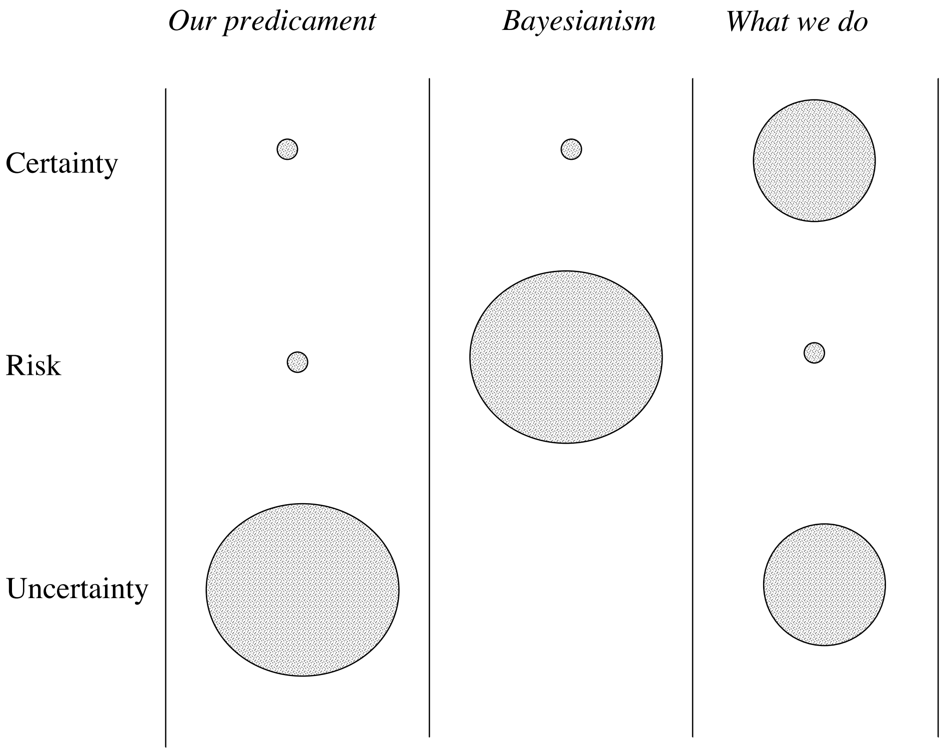

Figure 1. The reduction of epistemic uncertainty.

In practice, the degree of uncertainty-reduction provided by Bayesianism is insufficient to achieve a manageable belief system. Our cognitive limitations are so severe that massive reductions to full beliefs (certainty) are indispensable if we wish to be capable of reaching conclusions and making decisions.[4] As one example of this, since all measurement practices are theory-laden, no reasonably simple account of measurement would be available in a Bayesian approach (McLaughlin 1970). On the other hand, Bayesianism cannot either account for the fact that we also live with some unreduced epistemic uncertainties.

Figure 1. The reduction of epistemic uncertainty. The left column represents our predicament as it looks like in practice. Most of our beliefs are uncertain. Only in few cases do we have certainty, or precise probabilistic knowledge ("risk"). The middle column represents the Bayesian simplification, in which uncertainty is reduced to risk. The right column represents the simplification

that we perform in practice, treating many of our uncertain beliefs provisionally as if they were certain knowledge.

In my view, it is a crucial drawback of the Bayesian model that it does not take into account the cognitive limitations of actual human beings. Of course, we may wish to reflect on how a rational being with unlimited cognitive capabilities should behave, but these are speculations with only limited relevance for actual human beings. A much more constructive approach is to discuss how a rational being with limited cognitive capabilities can make rational use of these capabilities.

In practice, in order to grasp complex situations, we need to reduce the prevailing epistemic uncertainty not only to probabilities but also to full beliefs. Such reductions will have to be temporary, so that we can revert from full belief to probability or even to uncertainty, when there are reasons to do this. This is how we act in practice, and it also seems to be the only sensible thing to do, but we do not yet have a theory that clarifies the nature of this process (See Figure 1).

There are important lessons for risk research to draw from this. In risk analysis, it is mostly taken for granted that a rational individual's attitude to uncertain possibilities should be representable in terms of probability assignments. Due to our cognitive limitations, this assumption is not always correct. In many instances, more crude attitudes such as "This will not happen" or "It is possible that this may happen" may be more serviceable. Transitions between probabilistic and non-probabilistic attitudes to risk seem to be worth careful investigations, both from an empirical and a normative point of view. I believe, for instance, that such transitions are common in the process of technological design. An engineer designing a new product typically questions some parts of the construction at a time, while at least temporarily taking the reliability of the other parts for granted. This way of reasoning keeps uncertainty at a level at which it can be handled.

The process of uncertainty reduction is not a value-free or "purely epistemic" process. We are less reluctant to ignore remote or improbable alternatives when the stakes are high. Suppose that when searching for mislaid ammunition, I open and carefully check a revolver, concluding that it is empty. I may then say that I know that the revolver is unloaded. However, if somebody then points the revolver at my head asking: "May I then pull the trigger?," it would not be unreasonable or inconsistent of me to say "No," and to use the language of probability or uncertainty when explaining why. In this case, we revert from full belief to uncertainty when the stakes involved are changed.

Given our limited cognitive capabilities, this behavior appears to be quite rational. We have to reduce much of the prevailing uncertainty to (provisional) full beliefs. In order to minimize the negative consequences of these reductions, considerations of practical value must have a large influence on the reduction process. Once we take considerations of risk and uncertainty into account, it will be clear that epistemology cannot be independent of moral values or other practical values. This connection between epistemology and ethics is one of the major philosophical lessons that we can learn from studies of risk.

Philosophy of Science

In science, as well as in everyday life, cognitive limitations make a reduction process necessary. The corpus of scientific knowledge consists of those standpoints that we take, in science, for provisionally certain. It is, in fact, the outcome of an epistemic reduction process. However, there is one important difference between the scientific reduction process and that of everyday life: Science programmatically ignores considerations of practical value. More precisely, contrary to everyday reasoning, the scientific process of uncertainty-reduction is bound by rules that (at least ideally) restrict the grounds for accepting or rejecting a proposition to considerations unrelated to practical consequences. There are good reasons for this restriction. As decision-makers and cognitive agents with limited capacity, we could hardly do without a general-purpose, intersubjective, and continually updated corpus of beliefs that can for most purposes be taken to be the outcome of reasonable reductions of uncertainty.

The Burden of Proof

When determining whether or not a scientific hypothesis should be accepted for the time being, the onus of proof falls squarely to its adherents. Similarly, those who claim the existence of an as yet unproven phenomenon have the burden of proof. These proof standards are essential for both intra- and extrascientific reasons. They prevent scientific progress from being blocked by the pursuit of all sorts of blind alleys. They also ensure that the scientific corpus is reliable enough to be useful for (most) extra-scientific applications.

Nevertheless, the proof standards of science are apt to cause problems whenever science is applied to practical problems that require standards of proof other than those of science. Examples of this are readily found in risk-related decision-making. It would not seem rational—let alone morally defensible—for a decision-maker to ignore all preliminary indications of a possible danger that do not amount to full scientific proof. Therefore, such decisions have to be based on scientific knowledge, but yet apply proof standards that differ from those of science.

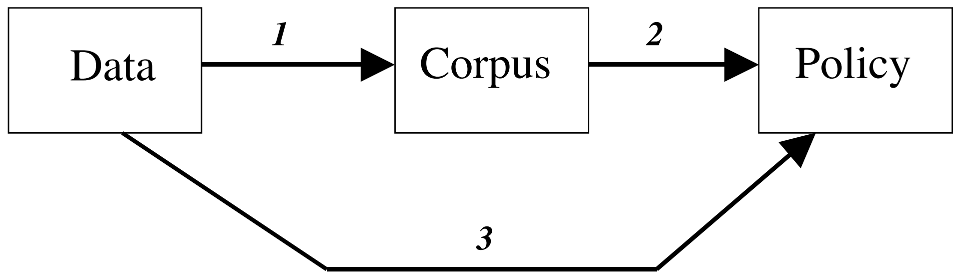

Figure 2. The use of scientific data for policy purposes.

The implications of this are shown in Figure 2. Scientific knowledge begins with data that originate in experiments and other observations. Through a process of critical assessment, these data give rise to the scientific corpus (arrow 1). Roughly speaking, the corpus consists of those statements that could, at the time being, legitimately be made, without reservation, in a (sufficiently detailed) textbook. The obvious way to use scientific information for policy purpose is to use information from the corpus (arrow 2). For many purposes, this is the only sensible thing to do. However, in the context of risk it may have unwanted consequences to rely exclusively on the corpus. Suppose that there are suspicions, based on relevant but insufficient scientific evidence, that a certain chemical substance is dangerous to human health. Since the evidence is not sufficient to warrant an addition to the scientific corpus, this information cannot influence policies in the “standard” way, arrows 1 and 2. However, the evidence may nevertheless be sufficient to warrant changes in technologies in which that chemical is being used. We want, in cases like this, to have a direct way from data to policies (arrow 3).

However, in order to avoid unwarranted action due to misinterpreted scientific data, it is essential that this direct road from data to policy be guided by scientific judgment in essentially the same way as the road from data to corpus. The major differences between the assessments represented by arrows 1 and 3 is that in the latter case, the level of required proof is adjusted to policy purposes. Scientists often have difficulties in coping with this situation. Engineers are more used to it. For more than a century, they have adjusted burdens and levels of proof to required levels of safety.

But we should not underestimate the problems involved in adjusting proof levels in the way required in the process represented by arrow 3. For one thing, new methods of statistical evaluation are often needed (Hansson 1995; 2002). Furthermore, we will have to deal with a proliferation problem: If we change the required levels of proof for certain issues, such as the presence of health risks, then we also have—at least in principle—to adjust the standards of proof for the more basic science on which we base our conclusions. Hence, suppose that we wish to apply, for policy purposes, adjusted standards of evidence to issues in toxicology. This will require a complete reform of the standards of evidence that will not only affect the interpretation of individual results in toxicology, but also our views on more basic biological phenomena. As an example, if our main concern is not to miss any possible mechanism for toxicity, then we must pay serious attention to possible metabolic pathways for which there is insufficient proof. Such considerations in turn have intricate connections with various issues in biochemistry, and ideally, we should perform a massive reappraisal of an immense mass of empirical conclusions, hypotheses, and theories. Presumably, this reappraisal could be performed by an ideal Bayesian subject, but it is far beyond the reach of human scientists of flesh and blood. Each of us has access only to small parts of the entire corpus of knowledge on which modern science is based, and this corpus has been shaped by innumerable fixations of belief that have accorded with ordinary scientific standards of proof. Partial adjustments can be made, but there is no way to realign the entire corpus to make it accord with standards of evidence other than those that have guided its development. Hence, although the scientific corpus has been developed as a source of general-purpose knowledge, it is not perfectly adjusted to all the purposes for which we need scientific knowledge. This is another basic philosophical insight that can be gained when we take issues of risk into serious consideration.

Limits of Scientific Knowledge—Indetectable Effects

Ideally, we want our decisions to be based on direct observations, rather than on more indirect conclusions. But how far can this be achieved? In issues of risk there are rather strong limits on what can be directly observed. Many risks are in fact indetectable. Let me explain why.

By the detection of a phenomenon I will mean that its existence is ascertained through some empirical observation that is only possible when the phenomenon exists. A phenomenon may be indetectable although there are convincing theoretical reasons to believe that it exists. If we add a small amount of hot water to a lake, the effect may be completely indetectable ex post. Whatever difference in temperature that we can measure is indistinguishable from random variations. But we know from elementary physics that our action has increased the temperature of the lake. This effect is knowable in spite of being indetectable.

Risks affecting human beings can be detectable either on the individual or only on the collective level (Hansson 1999b). The following hypothetical example can be used to clarify the distinction. There are three chemical substances A, B, and C, and 1000 persons exposed to each of them. Exposure to A gives rise to hepatic angiosarcoma among 0.5 % of the exposed. Among unexposed individuals, the frequency of this disease is very close to 0. Therefore, the individual victims can be identified. This effect is detectable on the individual level.

Exposure to B causes a rise in the incidence of leukemia from 1.0 to 1.5 %. Hence, the number of victims will be the same as for A, but although we know that about 10 of the about 15 leukemia patients would also have contracted the disease in the absence of exposure to the substance, we cannot find out who these ten patients are. The victims cannot be identified. On the other hand, the increased incidence is clearly distinguishable from random variations (given the usual criteria for statistical significance). Therefore, the effect of substance B is detectable on the collective (statistical) but not on the individual level.

Exposure to C leads to a rise in the incidence of lung cancer from 10.0 to 10.5 %. Again, the number of additional cancer cases is the same as for the other two substances. Just as in the previous case, individual victims cannot be identified. In addition, since the difference between 10.0 and 10.5 % is indistinguishable from random variations, the effects of this substance are indetectable even on the collective level.

We can therefore distinguish between effects that are completely indetectable, like the effects of substance C, and effects that are only individually indetectable, like those of substance B.

This example can help us to understand two important issues in risk management. The first of these is whether or not there is an ethical difference between cases A and B. This problem has been discussed, mostly with other types of examples, under the name of the *discrimination of statistical victims* (Weale 1979; Trachtman 1985). In case A, the victims are identified whereas in case B, they are unidentified (“statistical”). In actual social policies, statistical victims are often given a much lower priority than identified victims. Our societies are willing to pay much more to save known individuals in danger or distress than to reduce mortality or morbidity by measures not directed at identifiable individuals. Heart transplant candidates and trapped miners are examples of the former, whereas most measures undertaken for preventive purposes "only" save statistical lives, and receive much less funding per saved life. However, since the level of human suffering seems to be the same in both cases, it is not a trivial task to defend this difference in treatment from an ethical point of view. [5]

The other problem is whether or not completely indetectable effects, such as those in case C, are at all a matter of concern. In environmental policies it has often been implicitly assumed that what cannot be detected cannot be a matter of concern. Occasionally, this has also been explicitly stated. Hence, the Health Physics Society wrote in a position statement:

> ...[E]stimate of risk should be limited to individuals receiving a dose of 5 rem in one year or a lifetime dose of 10 rem in addition to natural background. Below these doses, risk estimates should not be used; expressions of risk should only be qualitative emphasizing the inability to detect any increased health detriment (i.e., zero health effects is the most likely outcome). (Health Physics Society 1996)

In my view, this is an untenable standpoint. A major reason for this is that indetectable effects may be much larger than what most of us are aware of.
To simplify the discussion, let us focus on lifetime risks of lethal effects. As a rough rule of thumb, epidemiological studies can reliably detect excess relative risks only if they are about 10 % or greater. For the more common types of lethal diseases, such as coronary disease and lung cancer, lifetime risks are of the order of magnitude of about 10 %. Therefore, even in the most sensitive studies, an increase in lifetime risk of the size 10^{-2} (10 % of 10 %) or smaller may be indetectable (i.e. indistinguishable from random variations). In animal experiments we have similar experimental problems, and in addition problems of extrapolation from one species to another.

How small health effects should be of concern to us? Many attempts have been made to set a limit of concern, expressed either as "acceptable risk" or "de minimis risk". Most of us would agree that if a human population is exposed to a risk factor that will, statistically, kill one person out of 10^9, then that risk is not an issue of high priority. Arguably, it would be no disaster if our risk assessment methods are insufficient to discover risks of that order of magnitude. On the other hand, most of us would consider it a serious problem if a risk factor kills one person out of 100 or 1000. The most common proposals for limits of concern for lethal risks are 1 in 100 000 and 1 in 1000 000. It is difficult to find proposals above 1 in 10 000. These values are of course not objective or scientific limits; I just report what seems the be levels at which lethal risks are accept*ed* (as distinguished from accept*able*).

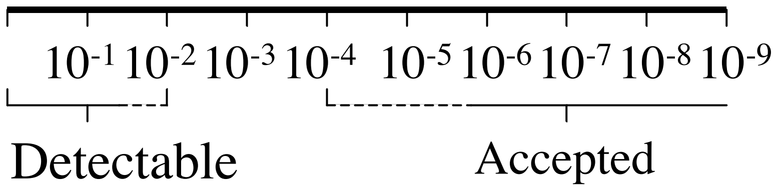

Figure 3. The ethical gap.

We therefore have what may be called an *ethical gap*, a gap between those (probabilistic) risk levels that are scientifically detectable and those that are commonly regarded to be ethically acceptable or at least of minor concern. This ethical gap, illustrated in Figure 3, has the breadth of 2–4 orders of magnitude. This gap is surprisingly unknown among risk assessors. One of the several practical issues that should be discussed, based on this knowledge, is the use of uncertainty factors ("safety factors") to bridge this gap. For a concrete example, if we consider the gap to be three orders of magnitude (i.e. if we accept risks smaller than 10^{-5}, then an uncertainty (safety) factor of 1000 is required to bridge the gap.

Ethics and Decision Theory

The above discussions of risk from the perspectives of epistemology and philosophy of science have shown how the issue of risk creates strong connections between these respective disciplines and moral philosophy (ethics). Let us now turn to moral philosophy itself.

The Division of Labor Between Ethics and Decision Theory

Moral philosophy is not the only philosophical subdiscipline that tries to answer the question "What should we do?". This is also done by another subdiscipline of philosophy, namely decision theory. However, according to the received view, these two subdisciplines do not compete, since they cover disjoint and clearly demarcated subject areas. Decision theory is assumed to take values for given and add no new values. It is therefore, in a sense, seen as morally neutral. In issues of risk, decision theory takes value assignments for deterministic cases for given, and derives from them instructions for rational behavior in an uncertain, unpredictable, and indeterministic world. Another way to express this is that, given preferences over deterministic alternatives, decision theory derives preferences over indeterministic alternatives.

Suppose, for instance, that moral considerations have led us to attach well-determined values to two outcomes *X* and *Y*. Then decision theory provides us with a value to be attached to mixed options such as 50%-chance-of-*X*-and-50%-chance-of-*Y*. The crucial assumption is that, given well-determined probabilities, and well-determined values of the basic, non-probabilistic alternatives *X* and *Y*, the values of mixed options can be *derived*. In other words, probabilities and the values of non-probabilistic alternatives are assumed to completely determine the value of probabilistic alternatives. This is the conventional wisdom, so conventional that it is seldom stated explicitly. I believe it to be grossly misleading.

It is clear that we assign values to (or have preferences over) both deterministic and indeterministic objects of value. It is also reasonable to expect that there be correlations and connections between these two types of preferences. However, I have found no good reason to believe that our intuitions on deterministic objects are always more reliable than our intuitions on indeterministic objects (Hansson 2001). To the contrary, we have in many contexts more experience from uncertain than from certain objects of value. It does not then seem reasonable to disregard all our intuitions on the former category from our deliberations, and reconstruct value assignments to them that are based only on our intuitions on the latter type of objects. Although not all combinations of deterministic and non-deterministic preferences are acceptable, a given set of deterministic preferences may be compatible with different (and mutually incompatible) sets of non-deterministic preferences.

In this perspective, the deductive reasoning of conventional decision theory should be replaced by *consolidative* reasoning (2001). Consolidation refers to the process of adjusting parts of a mental state in order to reduce its internal tensions. Consolidative reasoning may or may not lead to an end-point in the form of a reflective equilibrium. In real life, new tensions arise continuously in response to changes in the outer world, so that a reflective equilibrium may be as illusive as the end of the rainbow. Needless to say, this does not make the consolidative process less important.

In this perspective, moral philosophy and decision theory are not two distinct disciplines with separable subject matters, one of which should be treated prior to the other. Instead, the two disciplines have developed different approaches to one and the same problem—two approaches that stand in need for integration rather than separation. This is yet another major philosophical conclusion that seems to be unavoidable if we take issues of risk seriously—ethics and decision theory cannot any longer be kept apart.

The Causal Dilution Problem

Throughout the history of moral philosophy, moral theorizing has for the most part referred to a deterministic world in which the morally relevant properties of human actions are both well-determined and knowable. In recent years, moral philosophers have in most cases left it to decision theorists to analyze the complexities that the indeterminism of real life gives rise to. Mainstream ethical (and metaethical) theories still focus on deterministic problems; in fact they lack the means to deal with problems involving risk and uncertainty. As far as I can see, ethics still lives in a Newtonian world (Hansson 2003).

How can we generalize ethical theories so that they can be effectively applied to problems involving risk and uncertainty? The problem of how to perform this generalization can be specified in terms of *the causal dilution problem*.[6]

> *The causal dilution problem (general version)*: Given the moral appraisals that a moral theory T makes of value-carriers with well-determined properties, what moral appraisals does (a generalized version of) T make of value-carriers whose properties are not well-determined beforehand?

The term "moral appraisal" covers a wide range of assignments of moral status, such as declarations that something is forbidden, permitted, morally required, good, bad, better than something else to which it is compared, etc. The term "value-carriers" refers to all entities that can be assigned (moral) value, including in particular human actions and the outcomes of human actions.

Under conditions of risk, we can restate the causal dilution problem as follows:

> *The causal dilution problem (probabilistic version):* Given the moral appraisals that a moral theory T makes of value-carriers with well-determined properties, what moral appraisals does (a generalized version of) T make of probabilistic mixtures of such value-carriers?

How can major moral theories deal with the causal dilution problem?

Utilitarian Theories

There is an obvious but trivial answer to the causal dilution problem for utilitarianism (Bergström 1996, pp. 74–75). We can call it the "actualist" answer since it refers to what actually happens:

> *Actualism*: The utility of a (probabilistic) mixture of potential outcomes is equal to the utility of the outcome that actually materializes.

To exemplify the actualist approach, consider an engineer's decision whether or not to reinforce a bridge before it is being used for a single, very heavy transport. There is a 50 % risk that the bridge will fall down if it is not reinforced. Suppose that she decides not to reinforce the bridge and that everything goes well; the bridge is not damaged. According to the actualist approach, what she did was right. This is, of course, contrary to common moral intuitions.

The actualist solution requires that we use moral terms such as "right" and "wrong" in a way that differs radically from ordinary usage. If we accept the actualist usage, then it will in most cases be impossible to know what is right or wrong (or permitted, morally required, good, best, etc.) to do. In this way, action-guidance is expelled from moral discourse. However, action-guidance is largely what we need ethics for. Therefore, this is an unusually unhelpful approach. If we follow it, then action-guidance will have to be reintroduced in some other way.

The standard decision-theoretical solution to the utilitarian causal dilution problem is the maximization of expected utility. To maximize expected utility means to choose among a set of alternatives one of those that have the highest expected, i.e. probability-weighted utility. Hence this decision rule is based on a precise method for dealing with probabilistic mixtures.

> *Expected utility*: The utility of a probabilistic mixture of potential outcomes is equal to the probability-weighted average of the utilities of these outcomes.

The argument most commonly invoked in favor of maximizing objectivist expected utility is that this is a fairly safe method to maximize the outcome in the long run. Suppose, for instance, that the expected number of deaths in traffic accidents in a region will be 300 per year if safety belts are compulsory and 400 per year if they are optional. Then, if these calculations are correct, about 100 more persons per year will actually be killed in the latter case than in the former. We know, when choosing one of these options, whether it will lead to fewer or more deaths than the other option. If we aim at reducing the number of traffic casualties, then this can, due to the law of large numbers, safely be achieved by maximizing the expected utility (i.e., minimizing the expected number of deaths).

The validity of this argument depends on the large number of road accidents, that levels out random effects in the long run. Therefore, the argument is not valid for case-by-case decisions on unique or very rare events. Suppose, for instance, that we have a choice between a probability of .001 of an event that will kill 50 persons and the probability of .1 of an event that will kill one person. Here, random effects will not be leveled out as in the traffic belt case. In other words, we do not know, when choosing one of the options, whether or not it will lead to fewer deaths than the other option. In such a case, taken in isolation, there is no compelling reason to maximize expected utility.

Nevertheless, a decision in this case to prefer the first of the two options (with the lower number of expected deaths) may very well be *based on* a reasonable application of expected utility theory, namely if the decision is included in a sufficiently large group of decisions for which a metadecision has been made to maximize expected utility. As an example, a case can be made that a criterion for the regulation of safety equipment in motorcars should be one of maximizing expected utility (minimizing expected damage). The consistent application of this criterion in all the different specific regulatory decisions should minimize the damage caused by technical failures of motor vehicles.

The larger the group of decisions is that are covered by such a rule, the more efficient is the leveling-out effect. In other words, the larger the group of decisions, the larger catastrophic consequences can be leveled out. However, there is both a practical and an absolute limit to this effect. The *practical* limit is that decisions have to be made in manageable pieces. If too many issues are lumped together, then the problems of information processing may lead to losses that outweigh any gains that might have been hoped for. Obviously, decisions can be partitioned into manageable bundles in many different ways, and how this is done may have a strong influence on decision outcomes. As an example, the protection of workers against radiation may not be given the same priority if it is grouped together with other issues of radiation as if it is included among other issues of work environment.

The *absolute* limit to the leveling-out effect is that some extreme effects, such as a nuclear war or a major ecological threat to human life, cannot be leveled out even in the hypothetical limiting case in which all human decision-making aims at maximizing expected utility. Perhaps the best example of this is the Pentagon's use of secret utility assignments to accidental nuclear strike and to failure to respond to a nuclear attack, as a basis for the construction of command and control devices (Paté-Cornell & Neu 1985).

Even in cases in which the leveling-out argument for expected utility maximization is valid, compliance with this principle is not required by rationality. In particular, it is quite possible for a rational agent to refrain from minimizing total damage in order to avoid imposing high-probability risks on individuals.

To see this, let us suppose that we have to choose, in an acute situation, between two ways to repair a serious gas leakage in the machine-room of a chemical factory. One of the options is to send in the repairman immediately. (There is only one person at hand who is competent to do the job.) He will then run a risk of .9 to die due to an explosion of the gas immediately after he has performed the necessary technical operations. The other option is to immediately let out gas into the environment. In that case, the repairman will run no particular risk, but each of 10 000 persons in the immediate vicinity of the plant runs a risk of .001 to be killed by the toxic effects of the gas. The maxim of maximizing expected utility requires that we send in the repairman to die. This is also a fairly safe way to minimize the number of actual deaths. However, it is not clear that it is the only possible response that is rational. A rational decision-maker may refrain from maximizing expected utility (minimizing expected damage) in order to avoid what would be unfair to a single individual and infringe her rights.

There is one further problem with expected utility maximization: Just like utilitarianism, it is strictly impersonal. Utilities and disutilities that pertain to different individuals are added, with no respect being paid to the fact that they are bound to different persons.[7] Indeed, just as in ordinary utilitarianism, persons have no role in the ethical calculus other than as bearers of utilities whose value is independent of whom they are carried by. Therefore, a disadvantage affecting one person can always be justified by a sufficiently large advantage to some other person. This feature of expected utility calculations can be clearly seen in risk analysis. In mainstream risk analysis, benefits for one person may easily outweigh risk-exposure affecting other persons. Consider a polluting industry somewhere in Sweden. The total economic advantages to the Swedish population of this industry outweigh the total health risks that the pollution gives rise to. However, for those who live in the neighborhood the situation is radically different. The whole health risk burden that the pollution from the plant gives rise to falls on them.

Nevertheless, they receive a much smaller share of the economic advantages. In risk-benefit analysis, performed in the standard way as expected utility maximization, such distributional issues are disregarded. To the common moral intuition, this is an implausible way of thinking.

In summary, no plausible solution to the utilitarian causal dilution problem seems to be available.

Deontological and Rights-based Theories

Let us now turn to deontological and rights-based theories. The causal dilution problem for rights-based theories was formulated (in its probabilistic version) by Robert Nozick: "Imposing how slight a probability of a harm that violates someone's rights also violates his rights?" (Nozick 1974, p. 7; Cf. McKerlie 1986) In somewhat more general language we can restate it, and its deontological counterpart, as follows:

> *The causal dilution problem for deontological/rights-based moral theories (general version)*: Given the duties/rights that a moral theory T assigns with respect to actions with well-determined properties, what duties/rights does (a generalized version of) T assign with respect to actions whose properties are not well-determined beforehand?
>
> *The causal dilution problem for deontological/rights-based moral theories (probabilistic version)*: Given the duties/rights that a moral theory T assigns with respect to actions with well-determined properties, what duties/rights does (a generalized version of) T assign with respect to probabilistic mixtures of such actions?

An extension of a deontological theory to indeterministic cases can be obtained by just prescribing that a prohibition to bring about a certain outcome implies a prohibition to cause an increase in the risk of that outcome (even if the increase is very small). Similarly, for a rights-based theory, it could be claimed that if I have a right that you do not bring about a certain outcome, then I also have a right that you do not perform any action that has a non-zero risk of bringing about that outcome. Unfortunately, such a strict extension of rights and prohibitions is socially untenable. Your right not to be killed by me certainly implies a prohibition for me to perform certain acts that involve a risk of killing you, but it cannot prohibit all such acts. Such a strict interpretation would make human society impossible. I am allowed to drive a car in the town where you live, although this increases the risk of being killed by me (Cf. Fried 1978, pp. 18–20; Kagan 1989, p. 88).

Hence, rights and prohibitions have to be defeasible so that they can be cancelled when probabilities are small. The most obvious way to achieve this is to assign to each right (prohibition) a probability limit. Below that limit, the right (prohibition) is cancelled. However, as Nozick observed, such a solution is not credible since probability limits "cannot be utilized by a tradition which holds that stealing a penny or a pin or anything from someone violates his rights. That tradition does *not* select a threshold measure of harm as a lower limit, in the case of harms certain to occur" (Nozick 1974, p. 75)

Clearly, a moral theory need not treat a slight probability of a sizable harm in the same way that it treats a slight harm. The analogy is nevertheless relevant. The same basic property of traditional rights theories, namely the uncompromising way in which they protect against disadvantages for one person inflicted by another, prevents them from drawing a principled line either between harms or between probabilities in terms of their acceptability or negligibility. In particular, since no rights-based method for the determination of such probability limits seems to be available, they would have to be external to the rights-based theory. Exactly the same problem obtains for deontological theories.

Probability limits do not solve the causal dilution problem for these types of theories. As far as I am aware, no other solution of the causal dilution problem for these theories is available.

Contract Theories

Contract theories may perhaps appear somewhat more promising. The criterion that they offer for the deterministic case, namely consent among all those involved, can also be applied to risky options. Can we then solve the causal dilution problem for contract theories by saying that risk impositions should be accepted to the degree that they are supported by a consensus?

Unfortunately, this solution is far from unproblematic. Consent, as conceived in contract theories, is either actual or hypothetical. Actual consent does not seem to be a realistic criterion in a complex society in which everyone performs actions with marginal but additive effects on many people's lives. According to the criterion of actual consent, you have a veto against me or anyone else who wants to drive a car in the town where you live. Similarly, I have a veto against your use of coal to heat your house, since the emissions contribute to health risks that affect me. In this way we can all block each other, creating a society of stalemates. When all options in a decision are associated with risk, and all parties claim their rights to keep clear of the risks that others want to impose on them, the criterion of actual consent does not seem to be of much help.

We are left then with hypothetical consent. However, as the debate following Rawls's *Theory of* Justice has shown, there is no single decision-rule for risk and uncertainty that all participants in a hypothetical initial situation can be supposed to adhere to (See Hare 1973; Harsanyi 1975). It remains to show—if this can at all be done—that a viable consensus on risk-impositions can be reached among participants who apply different decision-rules in situations of risk and uncertainty. (If a unanimous decision is reached due to the fact that everybody applies the same decision-rule, then the problem has not been solved primarily by contract theory but by the underlying theory for individual decision-making.) As far as I can see, this has not been done, and hence, contract theory also does not have a solution to the causal dilution problem.

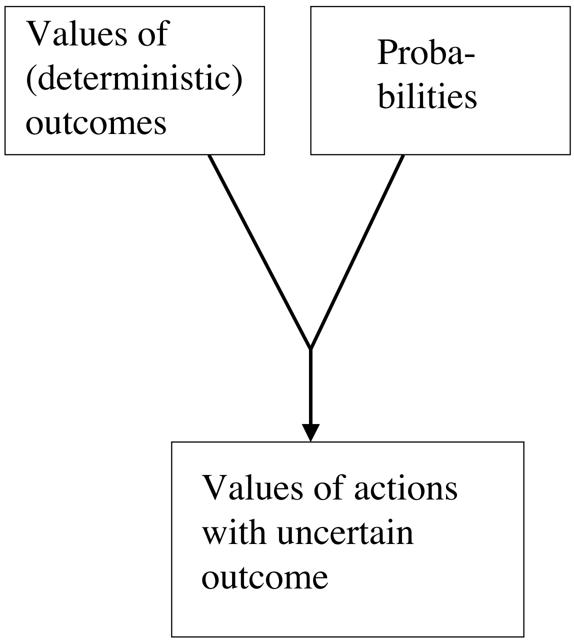

Figure 4. The standard view of how values of indeterministic options can be determined.

Restating the Problem

The difficulties that we encounter when trying to solve the causal dilution problem are indications of a deeper problem. In my view, the attempted solutions reviewed above are all based on an implicit derivation principle that is in fact quite implausible: It is assumed that given moral appraisals of actions with deterministic outcomes, we can derive moral appraisals of actions whose outcomes are probabilistic mixtures of such deterministic outcomes. In other words, it is assumed that probabilities and (deterministic) utilities are all the information that we need.[8] (Figure 4.)

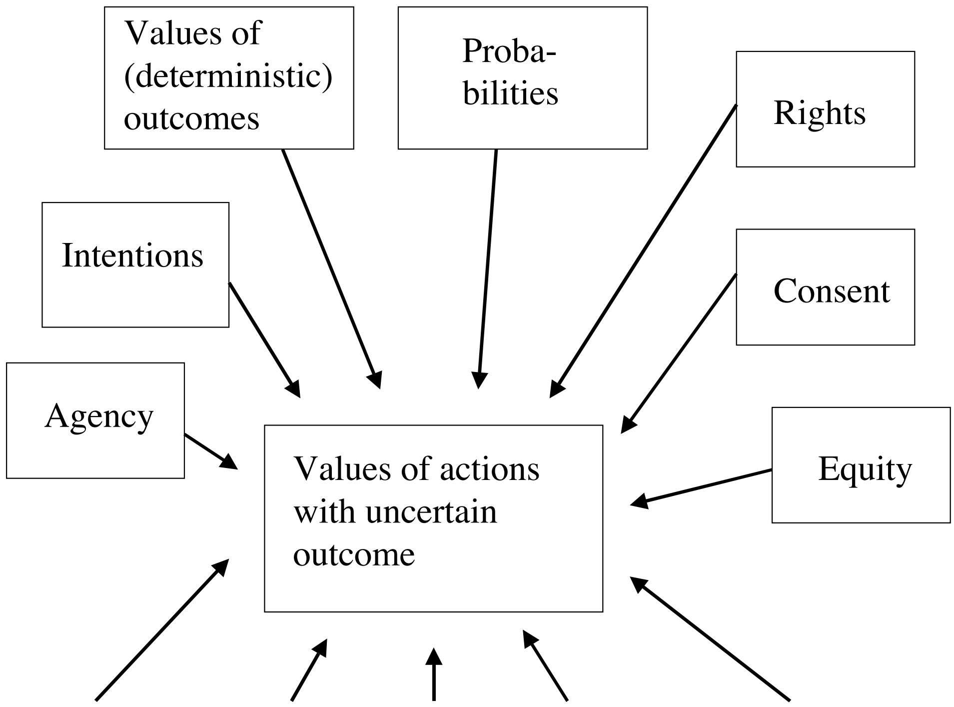

Figure 5. A less incomplete picture of the influences on the values of indeterminstic options.

In real life, there are always other factors in addition to probabilities and utilities that can—and should—influence a moral appraisal. The morally relevant aspects of situations of risk and uncertainty go far beyond the impersonal, free-floating sets of consequences that decision theory operates on. Risks are inextricably connected with interpersonal relationships. They do not just "exist"; they are taken, run, or imposed (Cf. Thomson 1985). To take just one example, it makes a moral difference if it is my own life or that of somebody else that I risk in order to earn a fortune for myself. Therefore, person-related aspects such as agency, intentionality, consent etc. will have to be taken seriously in any reasonably accurate account of real-life indeterminism. (Figure 5.)

A moral analysis of risk that includes considerations of agency and responsibility will be an analysis more in terms of the verb (to) "risk" than of the noun (a) "risk".[9] Major policy debates on risks have in part been clashes between the "noun" and the "verb" approach to risk. Proponents of nuclear energy emphasize how small *the risks* are, whereas opponents question the very act of *risking* improbable but potentially calamitous accidents.

We should therefore reformulate the causal dilution problem. I propose to replace it by an *exemption problem* that better reflects the moral issues of risk impositions:

> *The exemption problem:* It is a prima facie moral right not to be exposed to risk of negative impact, such as damage to one's health or one's property, through the actions of others. What are the conditions under which this right is overridden[10], so that someone is allowed to expose other persons to risk?

Attempts at a Solution

Let us now try an attack on the reformulated problem. A first, very simple, answer would be to refer to the weighing of risks and benefits.

> (1) Nobody should be exposed to a risk unless it is outweighed by a greater benefit.

This rule has the feature that we have seen above to be prominent in utilitarianism and in risk analysis: It allows us to expose one person to a risk in order to gain a benefit for someone else. We have already seen that this is implausible. What we need instead is a rule that respects the right of each individual not to be exploited by others who expose her to risks. Let us try going to the other extreme:

> (2) Nobody should be exposed to a risk unless it is outweighed by a greater benefit for herself.

This is very far-reaching, as we can see from our traffic example. It is of no use to me that people whom I do not know are allowed to drive a car in

Stockholm, but their car-driving increases the risk that I will be the victim of a traffic accident or of diseases related to air pollution. They, on their side, have no use for me driving a car. Hence, rule (2) could be used to stop all car traffic—and indeed almost all technological activities. It would probably make human society impossible.

But we can modify the rule. In the spirit of social contract theory, we can introduce reciprocally beneficial rights. If you and everybody else are allowed to drive a car, exposing me to certain risks, then I am allowed to drive a car and expose you to the corresponding risks. This (we may suppose) is to the benefit of all of us. Generalizing the argument, we can modify the rule as follows;

> (3) Nobody should be exposed to a risk unless either (i) it is outweighed by a greater benefit for herself, or (ii) it is part of a system in which several persons are exposed to the same risk, and the benefits for her from this system outweigh the risk.

Rule 3 makes it possible to allow much of what rule 2 would prohibit, such as car-driving. But it is still a very limiting rule. It allows for agreements that several persons accept one and *the same* risk in order for all of them to obtain advantages from this risk-taking. It allows us to exchange apples for apples, but not apples for pears. Let us consider yet another example. In your neighborhood there is a factory that produces product A, which you do not use. The factory emits a chemical substance that gives rise to a very small risk to your health. At the same time, another factory, far away from your home, emits other chemicals in the production of product B that you use. One of the neighbors of this second factory does not use product B, but instead uses product A. In this way, and sometimes in much more complex chains, we may be said to exchange risks and benefits with each other. To justify this, we can introduce the following rule:

> (4) Nobody should be exposed to a risk unless it is part of a social system for risk-taking that works to her advantage.

Rule (4) allows everything that rule (3) allows, and more in addition to that. It has the important advantage of recognizing each person's individual rights (contrary to impersonal moral theories such as utilitarianism) but still making mutually beneficial adjustments possible (contrary to straight-forward applications of a theory of rights).

But rule (4) is not unproblematic. There is a remaining problem that can be seen from the following example: Suppose that the labor force in a society is divided into two classes. Members of the higher class lead a protected life, whereas members of the lower class are exposed to large occupational risks. For members of the higher class, this social system is highly advantageous. For members of the lower class, it is only marginally better than living outside of society. Rule (4) would not forbid this.

We therefore need to adjust the rule by including a clause of justice. We should acknowledge that the individual who is exposed to risks has a right to require, not only that the social system of risk should be to her advantage, but also that she receives a fair share of these advantages:

> (5) Nobody should be exposed to a risk unless it is part of an equitable social system for risk-taking that works to her advantage.

This is my preliminary proposal for a general criterion for the social acceptance of risks. It needs, of course, to be specified in several respects, both for theoretical purposes and to make it useful in concrete applications.
Finally, let us compare this proposal to the dominating approach in risk analysis, that can be summarized as follows:

> (RA) A risk imposition is acceptable if the total benefits that it gives rise to outweigh the total risks, measured as the probability-weighted disutility of outcomes.

By choosing a rule such as (5), rather than (RA), we change the agenda for discussions on risk. We choose to treat each risk-exposed person as a sovereign individual who has a right to a fair treatment, rather than as a carrier of utilities and disutilities that would have the same worth if they were carried by someone else. We also choose another standard of proof. In order to argue, according to (RA) that it is acceptable to impose a risk on Ms. Smith, one has to give sufficient reasons for accepting the risk as such, as an impersonal entity. According to (5), one instead has to give sufficient reasons for accepting that Ms. Smith is exposed to the risk.

The lack of a qualified ethical analysis is probably one of the major reasons why so many mistakes have been made in the management of technological risks. As philosophers of technology, we can contribute to improving risk management and risk governance. At the same time, philosophy of risk provides us with new and theoretically important insights in areas as diverse as epistemology, philosophy of science, decision theory, and ethics. Both practically and theoretically, I believe this to be one of the most fruitful areas of study in present-day philosophy.

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Notes

[1] The special case when all probabilities are either 0 or 1 coincides with decision-making under certainty.

[2] The case when they are not known at all is also called “decision-making under ignorance”. On cases when not even the identity of the possible outcomes is known, see Hansson 1996.

[3] The word ‘reduction’ is used metaphorically. I do not wish to imply that all probability assignments or full beliefs have been preceded by more uncertainty-laden belief states, only that they can be seen as reductions in relation to an idealized belief state in which uncertainty is always fully recognized.

[4] This is one of the reasons why belief revision models that represent belief states as sets of (sentences representing full) beliefs are an important complement to probabilistic models. Some features of doxastic behavior, notably features related to logic, are more realistically represented in the former type of models. See Hansson 1999a.

[5] However, an argument can be made that refers to the special duties that we are assumed to have to certain people. I have, for instance, special duties to my children. My duty to come to their assistance is greater than my corresponding duties to my neighbour's children. Similarly, my duties towards the neighbour's children, with whom I am reasonably well acquainted, are stronger than those towards complete strangers. There is a special weight emanating from relationships between specific individuals. This special weight is not necessarily zero for people towards whom I have no other special relationship than that of being fellow human beings. To the contrary, it would seem natural to assume that it is still above zero for them, and zero only for persons who have not even been identified. It can then be argued that the trapped miners stand in the same type of relationship to the statistical beneficiaries of preventive medicine as my kin and friends to the trapped miners. – In many cases, the morally relevant special relations between identified persons can be expressed in terms of rights. The trapped miners may be said to have a right to our assistance, whereas in the case of the statistical victims there are no identifiable rights-holders and hence no rights.

[6] There is also another form of causal dilution, that arises when one’s action is one of several contributing causes of an outcome. The present paper deals only with such causal dilution that is due to uncertainty of the effects of actions.

[7] The addition of utilities and disutilities pertaining to one and the same person is not either unproblematic, but that issue will not be discussed here.

[8] The maximin rule goes one step further, i.e. it dismisses probabilities and makes use only of (deterministic) utilities.

[9] The notion of risking is in need of clarification. In order to risk something, must I increase its probability, or causally contribute to it? Can I be said to risk an outcome that I have no means of knowing that I contribute to? The discussion of these definitional issues will have to be deferred to another occasion.

[10] We should require only that the right be overridden, not that it be cancelled altogether (See Hansson & Peterson 2001).

Engineering Ethics and Computer Ethics: Twins Separated at Birth?

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Over the past two decades, engineering ethics and computer ethics have emerged as identifiable fields of applied ethics. While some individuals have made contributions to both fields, for the most part they have developed in the USA along parallel, but separate paths. In previous presentations (O'Connell & Herkert 2001a; 2001b) we have argued that material drawn from computer ethics should be standard fare in all engineering ethics treatments, not just those aimed specifically at computer engineers and scientists. This conclusion emerges from the ever-expanding prominence of computer technology in both engineering education and practice and the form of engineered products. As noted by William Wulf (1997), a University of Virginia Professor and President of the National Academy of Engineering:

> The pervasive use of information technology in both the *products and process of engineering*…has the potential to change the practice of engineering significantly, and hence the education required to be an engineer…As the power of computers…increases exponentially, more and more routine engineering functions will be codified and done by computers, simultaneously freeing the engineer from drudgery and demanding a higher level of creativity, knowledge, and skill. [emphasis added]

The importance of social and ethical implications of computing with respect to engineering practice and products should also not be ignored. For example, George Fisher (2000), Chairman of the Board of Eastman Kodak Company, who compares the impact of "digital computing and communication" to that of the printing press notes that "integrating human needs (with respect to information and communication technology) is engineering's biggest challenge and opportunity."

Despite its domineering role in all of contemporary engineering education and practice, computer technology is afforded little if any special consideration in standard treatments of engineering ethics (see for example Harris, Pritchard, &

Rabins 2000; Martin & Schinzinger 1996; Whitbeck 1998) except when the target audience is explicitly computer engineers. In contrast, chapters on environmental ethics are typically found in general engineering ethics texts (see again Harris, Pritchard, & Rabins 2000; Martin & Schinzinger 1996; Whitbeck 1998)—indeed, some engineering ethics texts focus primarily on environmental issues (see for example, Gorman, Mehalik, & Werhane 2000).

Examples of computer-related ethical issues that are of importance to engineers of all disciplines are intellectual property in the digital age, privacy, and computer systems reliability. Issues relating to the ownership of digital material have become increasingly relevant to engineering for a variety of reasons. Computers have become integral elements of design, manufacturing and control of even the most conventional of devices. Questions affecting the ownership of instruction sets, firmware, interfaces, routines and applications are thus of extreme significance to a wide variety of actors, from design to implementation and beyond. Computing has also become a primary vehicle for the dissemination of information in the form of digitally mediated journals and books, to networked communication by electronic mail. Within the United States, the constitutional mechanisms of copyright and patent law have been animated by a policy of limited protection of intellectual material. The doctrine of "fair use" and the time-limitations of the patent protection are examples of provisions favorable to the public access of scientific and technical information.

Currently, a number of legal initiatives have been enacted which have increased ownership controls of digital material to beyond that which was permitted under traditional policies. The matter of *Universal City Studios* v. Corley (2001), involved the reverse engineering of the "Content Control System" (CSS), a proprietary device used by the movie industry to encrypt DVD material in order to prevent copying. This effort produced the creation of the " DeCSS" program, which, among other things allowed the copying of DVD material. In the ensuing suit to enjoin the use or communication of DeCSS, the defendants, operators of a Web site which had published the code, claimed, with the support of many from science, engineering and academic law, that a prohibition would prevent many "fair uses" of the technology, enabling producers of information to lock-out access at their discretion, and to the detriment of the public. The DeCSS case represents a new, unprecedented trend toward information restriction that threatens a wide variety of activities within the scientific and technical environment.

Privacy presents another area in which computing has brought with it new issues and paradigms for analysis. Due to the data-centered nature of digital devices, it is possible to easily create many forms of data collection within many types of computer-related applications. Because the actions of the computer frequently occur beyond the "front-end" of a device, it is often impossible for users to know that their data is being collected. Similarly, the use of digital data collection opens the door to uses that may not have been contemplated or anticipated by designers. The development of ":Cue Cat" is an example of these wide-ranging effects. This hand-held instrument employs an optical scanner to read bar codes embedded in such mediums as conventional publications to directly access Web sites or search pages. This enables readers to avoid the need to type complex URL's into their browsers and affords instant connections to online information and services. The technology has been criticized for its less-publicized ability to track user actions through its assignment of unique identity codes to individual units (Olsen 2000). The :Cue Cat serves as an example of the need to recognize that digital devices present inherent potentials for unanticipated or undesirable uses of information, well beyond that of analog counterparts.

Another area of concern for engineering involves the increasing role of computer-generated or mediated data. Although engineers are well acquainted with the importance of measurement within their fields, it has been suggested that they are often less aware of the inherent problems associated with computer-related information. Often, computerized information is derived from models that are created by programmers who are not versed in the real-world dynamics. In real-world applications, investigators have noted an over-reliance placed upon software by engineers who are not familiar with its developmental processes and shortcomings (Leveson & Turner 1993). The disastrous results of the Therac-25 radiological devices, considered in more detail within, exemplify how engineering competence must extend to core aspects of computing.

In the rest of this paper, we expand on this theme and address the more general question of how engineering ethics and computer ethics stand to benefit further from one another, in both education and research.

Lessons from Engineering Ethics

In this section, we propose that the most valuable contribution engineering ethics offers to computing is its mature sense of identity. We submit that this identity is linked to broadly accepted, core professional practices, which are strongly materialist. Flowing from this recognition is an ethical posture informed by realistic and comprehensive understandings of purposes, effects and implications. We will contrast this with the state of computing, which by tradition, but not necessity, possesses a self-image which emphasizes theory and abstraction. As a consequence, there is minimal consideration of ethics as an intrinsic element of practice.

At first glance, contemporary computing and engineering ethics seem to be so similarly situated that neither pursuit would appear to have much to offer the other, except in the way of encouragement shared between two newly evolving disciplines. Both fields remain dynamic and unstable as they pursue substantive development and recognition within their respective communities. In these instances, engineering and computer ethics are similarly engaged as relatively new institutional actors and their recency presents problems for a useful interdisciplinary exchange of ideas.

Engineering and the Ethics of Practice

Institutional developments, significant as they are, do not define the limits of ethical resources. While the birth of contemporary engineering ethics is placed in the 1970's (Lynch 1997/1998), concerns about the moral implications of its endeavors likely pre-date conventional history altogether. As Albert Jonsen (1998) stated within the context of medicine, modern conceptions of professional ethical behavior did not begin with a "Big Bang." Instead, early and fundamental, working definitions of ethics are most clearly derived from the specifics of practice. Thus, Dr. Richard Cabot (1869-1939) essentially defined ethical medical behavior as competence as a practitioner. Significantly, this definition was not confined to purely technical skill, but involved a broader, "appreciation of the personal and social needs of the patient" (Jonsen 1998, p. 9).

While modern engineering ethics have gone well beyond the realm of simple competence, the role of practice retains pre-eminence within its ethical analyses. Contemporary engineering ethicist, Michael Davis (1999) affirms this when he resists separating ethical from practical aspects of engineering, stating that "engineering ethics is part of thinking like an engineer".

Ethics, according to this perspective, requires a substantial understanding of the actual activities involved within the profession. It is an epistemic process, which demands technical, material knowledge sufficient for the widest possible consideration of goals, implications and effects. Efforts, both scholarly and popular, continue to advance descriptions of core activities that define engineering as an activity.

In his study of this issue, Walter Vincenti (1990) initially employs the definition of G.F.C. Rogers:

> Engineering refers to the practice of organizing the design and construction of any artifice which transforms the physical world around us to meet some recognized need (quoted in note 4b).

Extrapolating from this definition, Vincenti concludes that "(e)ngineering knowledge reflects the fact that design does not take place for its own sake and in isolation". Rather, it occurs as "a social activity directed at a practical set of goals intended to serve human beings in some direct way" (Vincenti 1990). Davis (1998) also alludes to this attribute of engineering when he refers to it as "sociological knowledge, a knowledge of how people and tools work together, but it is nonetheless engineering knowledge."

A comprehensive analysis of the dynamics involved in the joining of practice to ethics is beyond the scope of this paper. It is however, important to note two attributes of this condition. The first concerns focus. By associating its essential activities with human effects and interests, engineering has implicitly included issues of public accountability and responsibility within its framework. Thus, ethical reflection is, as Davis states, a natural aspect of thinking like an engineer. The second attribute involves relevance. The grounding of ethics to actual practice imparts an increased confidence that value judgments will be responsive to the issues encountered. The influence of this perspective upon the activities and pedagogy of engineering ethics are considered within. Of immediate significance, is the contrast between this approach and that of computing.

Any comparison of computing with engineering must initially take into account significant developmental differences. Modern engineering has evolved from ancient roots rich in references to the practical, "transformation of the physical world". Until relatively recently, it has been largely regarded internally and popularly, as a unitary profession (Davis 1998, p. 22). Even the advent of specialization has not erased a public and scholarly acknowledgment of commonality, or what Layton has termed a "professional nucleus" which is differentiated by individual professional societies (1986, p. 26). This status has doubtlessly supported a shared notion of purpose and has facilitated the consideration of common, practice-specific values.

Computing and Abstraction

In contrast, computing possesses a more disparate heritage. Its origins may be located within mathematics as well as philosophy, with more recent advances emerging from such diverse disciplines as electrical and electronic engineering, physics, economics, psychology and biology (Davis 2000). Many founding (and still influential) actors migrated from their original fields to the new disciplines of computer science and computer engineering. These developments imparted a degree of professional identity, but for reasons examined below, they have also produced significant effects on the focus and nature of computing ethics.[1] Additionally, unlike engineering, computing has arisen mainly from academic settings. Consequently, while specific, tangible and commercial achievements such as mainframes or the personal computer are lauded, academically oriented subjects remain central to the field's identity, as is evidenced by the title of a popular text, *Algorithmics: The Spirit of Computing* (Harel 1987).[2]

An ethics of practice is generated by a substantially shared vision of primary activities. Whether by reference to "design", "organization", "construction", or similar terms, engineering possesses a core understanding of itself, which implicitly incorporates the idea of social responsibility. Layton (1986) and others have discussed how this understanding has been imperfectly applied and even avoided. Nevertheless, the presumption of its existence remains constant. In contrast, computing has largely evolved from mathematics and the theoretical sciences. Many founding members of computing faculties have been drawn from these disciplines and often retain a primary identification with their original fields. In these environments, competence is commonly defined as facility with such abstract subjects as algorithms, formal languages and logic. The consideration of material or social effects, while certainly possible, cannot be assumed as a natural outcome of these activities.

It is undeniable that abstraction is thus a critical component of computing. What can be questioned is how it is represented within the curriculum and the profession. Most frequently, it is exists in a hermetic state, detached from real world problems and effects. Consequently, the role of ethical study, though not totally incapacitated, arguably takes on a forced and almost intrusive quality—imported as an after-thought rather than an intrinsic consideration.

Arguably, assisted by the lack of a "native" practice-centered ethic, curricular and scholarly work in the field has largely emerged from a collaborative effort between computing and such external disciplines as philosophy, law, the behavioral sciences and theology. This is not a unique or negative development, as the results of a similar evolution of modern biomedical ethics will attest. However, as addressed below, it does raise issues regarding the balance of disciplinary participation, including the question of which discipline exerts the most influence in the setting of agendas.

Based upon these circumstances, the current condition of computing exhibits two related and problematic ethical situations, both typified by disconnection. The first and most controversial submission is that computing as an activity has remained, due to its dominant self-definition, disconnected from reality.

While there was arguably a time when computing could be viewed as the pure activity of symbolic manipulation, the moment was shorter than is generally acknowledged. Almost immediately after their production and limited dissemination, computers became involved in human affairs, most ostensibly through the processing of personal data and the specter of automated decision-making. As early as 1971, the direct effects of computers on human relationships had been identified as a critical contemporary and future problem. Significantly, the threat was presented as a professional issue. Harold Sackman makes this clear when he comments that "universities are turning out the first generation of theoretically oriented computer scientists—scientists interested in hardware and software, but not people—scientists who are too often temperamentally and technically unsuited for the vast work of building a computer-serviced society" (1972, p. 17).

Similar early concerns for the human effects of computing were addressed by Joseph Weizenbaum (1976). In an interesting contrast with the engineer's "inextricable" concern for the material world, he states:

> One would have to be astonished if Lord Acton's observation that power corrupts were not to apply in an environment in which omnipotence is so easily achieved. It does apply. And the corruption evoked by the computer programmer's omnipotence manifests itself in a form that is instructive in a domain far larger (than) the immediate environment of the computer (p. 115).

The "Eliza effect" (Nelson 2001), is appropriately named after a program created by Joseph Weizenbaum (1976) to study aspects of text scripting, but which gained unanticipated fame for fostering illusions of intelligence in many who observed its operation. It is a term now used to describe the belief that digital output is inherently more "trustworthy" than that generated by the material world. Such an attitude was a primary ingredient in the incidents surrounding the THERAC-25 medical devices. Here, misplaced faith in software-mediated radiological measurements resulted in serious injury and death (Leveson & Turner 1993). On a more metaphysical, but also ethical level, commentators have submitted that trust in the superiority of abstraction as represented by some advocates of artificial intelligence, virtual reality applications and cybernetics, significantly degrade valuation of the material, including human beings, at least as physical entities (Heim 2000; Hayles 2000).

The point made throughout this commentary is that regardless of abstraction's epistemological dominance, computing is indeed powerfully connected to real-world effects. This has been true in the past and is even more so today with the ubiquitous use of "intelligent" devices in medicine, transportation, environmental processes and other safety-critical systems. The failure to engender a practice-centered ethical perspective in computing has resulted in the masking of such material issues in computing's self-identity, particularly as communicated through its basic teaching, research and internal dialogues. Evidence of this deficit can be witnessed in numerous ways, ranging from the paucity of ethical content in "serious" technical papers to "hard" computer science courses, which never mention the ethical implications of their subject.

This condition leads to the second major effect caused by computing's practice-centered void, a condition which might be termed "disciplinary drift". While wide collaboration is of unquestionable value, those in computing may be tempted to delegate choices of problems and analytical approaches to non-practitioners. In such instances, there is significant risk that issues relating to practice will be missed.

Equally problematic are texts that broadly address policy issues, but leave it to the reader to supply or even correct the technical details. When written by non-computing experts, there is a risk of incomplete integration and the creation of an illusion that ethical issues only emerge in certain, often-ethereal contexts. Indeed, ethics may be presented as literally requiring a "federal case". Authors unfamiliar with the practice of computing appear more particularly susceptible to the embracing of analogies and terminology, which, while popular in the pages of popular "e-zines", are entirely inappropriate to real practice scenarios. A common example is the ubiquitous use of the term "cyberspace" to represent a non-existent dimension envisioned largely by non-technically oriented commentators and "visionaries" (Koppell 2000).

Engineering ethics is not without abstraction, but in contrast with computing, it is animated by a robust and active movement concerned with the seamless identification of ethics with practice. Gorman, Hertz, Magpili, Mauss, & Mehalik (2000, p. 463) point to the necessity of cultivating the "heterogeneous engineer" who is "adept in understanding the entire context of a problem." Through the use of "moral imagination" (Werhane 1994)—an ability to assume perspectives beyond that of the technical actor—these authors lay a theoretical groundwork for engineering as "reflective practice".

The blending of ethical considerations with practice issues is apparent in a number of projects undertaken within engineering education. Examples include design courses that present computational accuracy as an ethical issue (Goddard 2001), case studies that combine technical problems with ethical scenarios (Pritchard & Holtzapple 1997), and faculty education directed toward developing sensitivity to ethical problems encountered within industry (Gorman et al. 2001). A particularly poignant example of this approach, described by Catalano et al. (2000), involved a capstone engineering design experience that focused on the needs of an individual with advanced cerebral palsy. Follow-up interviews with the students, graduating members of the United States Military Academy, included reports of sensitization to the need for technical and financial resources directed toward the disabled, the achievement of growth "both as engineers and as people," and the accomplishment of their project as "a labor of love".

There is no feature of computing which would render it unable to engage in similar programs. The critical stumbling block has been a general failure to regard its most intrinsic aspects directly relevant to the material, everyday world. There are a number of positive signs that computing is recognizing this necessity. Professional forums such as the ACM's Forum on Risks to the Computer Public in Computers and Related Systems is a particularly salient example (Neumann) as are the commentaries generated in the evolution of software engineering (Pour, Griss, & Lutz 2000). A more general correction is also possible, but only if computing's practical dynamics are elevated to a level of prestige which approaches that accorded to its theoretical dimensions.

Lessons from Computer Ethics

The strong grounding in practice of engineering ethics does not come without a cost. As noted above, the implicit commitment to social responsibility imbedded in such an approach is often hard to realize in the actions of engineers and professional engineering societies. Ironically, though as we argued above, computing is far less grounded in practice, the field of computer ethics has done a much better job to date of integrating "microethical" and "macroethical" perspectives in research and education.

Microethics and Macroethics in Engineering (Herkert 2001; 2003)

A number of authors have suggested that engineering ethics encompasses multiple domains. The ethicist John Ladd (1980) subdivides engineering ethics into "micro-ethics" or "macro-ethics" depending on whether the focus is on relationships between individual engineers and their clients, colleagues and employers, or on the collective social responsibility of the profession. In each case Ladd seems to be concerned with what might be called "professional ethics," with micro-ethics focusing on issues for the most part internal to the profession and macro-ethics referring to professional responsibility in a broader, societal context.

McLean (1993), an engineer, utilizes three categories in discussing engineering ethics: technical ethics, dealing with technical decisions by engineers; professional ethics, dealing with interactions among managers, engineers and employers; and social ethics, dealing with sociopolitical decisions concerning technology. McLean's notion of professional ethics is narrower than Ladd's, incorporating only those dimensions that Ladd describes as micro-ethics. At the same time, McLean has a broader overall notion than Ladd of the spheres of ethics that are relevant to engineering for he includes both individual and societal dimensions. Another engineer, Vanderburg (1995), while employing terminology similar to Ladd's, seems to neglect professional ethics entirely while distinguishing between "microlevel" analysis of "individual technologies or practitioners" and "macrolevel" analysis of "technology as a whole," categories that track to McLean's technical and social ethics categories.

De George, an ethicist, distinguishes between "ethics in engineering," and "ethics of engineering" (Roddis 1993). The focus of the former is on actions of individuals while the latter is concerned with both relationships internal to the profession *and* the responsibilities of the engineering profession to society. De George's notion of "ethics of engineering" thus incorporates both Ladd's micro and macro dimensions. In addition, the "ethics of engineering" specifically includes professional engineering societies.

As shown in Table 1, when combing these various facets of engineering ethics, an interesting pattern emerges. Three frames of reference are apparent: individual, professional and social. Combining Ladd's and Vanderburg's terminology, "microethics" can be seen to include concern with individuals and the internal relations of the engineering profession, while "macroethics" applies to both the collective social responsibility of the engineering profession and to societal decisions about technology.

Heretofore, most research and teaching in engineering ethics has had a micro focus either in the sense Vanderburg uses the term or the sense in which Ladd uses it. This state of affairs is lamented by Winner, who is critical of the over emphasis in engineering ethics on case studies of microethical dilemmas to the exclusion of larger issues relating to the development of technology:

> Ethical responsibility...involves more than leading a decent, honest, truthful life, as important as such lives certainly remain. And it involves something much more than making wise choices when such choices suddenly, unexpectedly present themselves. Our moral obligations must...include a willingness to engage others in the difficult work of defining what the crucial choices are that confront technological society and how intelligently to confront them (1990, p. 62).

Recently, scholars have begun to address macroethical issues in connection with engineering (Herkert 2000; Lynch & Kline 2000; Woodhouse 2001). Yet to be developed, however, is a comprehensive framework for integrating microethical and macroethical approaches in engineering ethics. Indeed, as suggested in the critiques of Ladd and Winner, many scholars and teachers of engineering ethics explicitly exclude macroethics as a fundamental focus in engineering ethics.

A lack of appreciation of the role of macroethical perspectives is reflected in popular definitions of engineering ethics, such as the following passages from two of the leading engineering ethics texts:

> Engineering ethics is (1) the study of moral issues and decisions confronting individuals and organizations engaged in engineering and (2) the study of related questions about the moral ideals, character, policies and relationships of people and corporations involved in technological activity (Martin & Schinzinger 1996, p. 2-3)
>
> Engineering ethics is concerned with the question of what the standards in engineering ethics should be and how to apply these standards to particular situations. One of the values of studying engineering ethics is that it can serve the function of helping to promote responsible engineering practice. (Harris, Pritchard, & Rabins 2000, p.26)

The apparent disconnect between microethics and macroethics in engineering is problematic for a number of reasons (Herkert 2004). From a societal viewpoint, we need policies that are ethical and ethical viewpoints that are sensitive to social problems and issues. For example we should question a product liability policy that might make it more difficult for engineers to perform their jobs in an ethical manner, thus compromising public safety (Herkert 2001; 2003). On the other hand, an ethical stance that all technology should be risk free on the grounds that engineers have a duty to avoid harm would clearly run counter to societal needs and economic realities.

From the individual's viewpoint, engineers need ways of dealing in a consistent and holistic manner with ethical issues that arise in their various roles. In the absence of integration of ethical considerations from their personal and professional roles with issues that may arise in their public roles, engineers might become confused or complacent regarding the importance of ethics in all of these roles.

Microethics and Macroethics in Computing

In contrast to engineering ethics, computer ethics has often been broadly defined so as to include both microethical and macroethical aspects. This tendency dates at least as far back as James Moor's seminal 1985 article, "What is Computer

Ethics," in which he argued that "…computer ethics includes consideration of both personal and social policies for the ethical use of computer technology."

Even when attention turns from research to pedagogy, the computer ethics community seems to take a broader view of their field than does the engineering ethics community. For example, in highlighting the goals of engineering ethics instruction, Davis' focus (1999) remains squarely on the microethical:

> Teaching engineering ethics…can achieve at least four desirable outcomes: a) increased ethical sensitivity; b) increased knowledge of relevant standards of conduct; c) improved ethical judgment; and d) improved ethical will-power (that is, a greater ability to act ethically when one wants to).

In contrast, Johnson's groundbreaking classic text on computer ethics (1994) prominently includes understanding of the societal context of computer technology within the goals of computer ethics courses (note especially items 3 and 4):

> (1) to make students (especially future computer professionals) aware of the ethical issues surrounding computers;
>
> (2) to heighten their sensitivity to ethical issues in the use of computers and in the practice of computing professions;
>
> (3) to give them more than a superficial understanding of the ways in which computers (do and don't) change society and the social environments in which they are used;
>
> (4) to provide conceptual tools and develop analytical skills for sorting out what to do when in situations calling for ethical decision making or for sorting out what the likely impacts computer technology will have in this or that context (p. 6).

Indeed, in a review of the field of computer ethics Mitcham notes that in Johnson's text "she commonly weaves together professional ethical, legal, governmental, and societal concerns" (1995, p. 119). Mitcham goes on to argue for the importance of societal concerns in reevaluating traditional approaches to ethics and integrating them with practice:

> Such professional efforts to take into account general societal concerns about the right to privacy clearly constitute efforts not only to reevaluate the application of traditional ethical principles, but also to establish new agreements about both principles and practices in the presence of computers and other new electronic information technologies (p. 120).

The broader perspective of computer ethics also extends to accreditation of professional programs and educational standards recommended by professional societies, suggesting that the profession's view of the scope of computer ethics is similar to and perhaps influenced by that of the computer ethics community. In engineering, the focal point of attention on Engineering Criteria 2000 (EC 2000) of the Accreditation Board of Engineering and Technology (ABET) has been on Criterion 3, which specifies program outcomes and assessment. Among other outcomes, "engineering programs must demonstrate that their graduates have…an understanding of professional and ethical responsibility…[and] the broad education necessary to understand the impact of engineering solutions in a global and societal context." (ABET-EAC, 2003) There is no suggestion in EC 2000, however, that these criteria necessarily have anything in common, or that they can or should be approached in integrated fashion.

The current ABET criteria for accrediting Computer Science are equally vague, providing only that "[t]here must be sufficient coverage of social and ethical implications of computing to give students an understanding of a broad range of issues in this area." (ABET-CAC 2003) Professional groups, however, have gone far beyond this, by suggesting detailed criteria for the integration of ethical and social issues in the computer science curriculum. For example, an integrated curriculum model for ethical and social impacts of computing (ES) was developed in Project ImpactCS (ComputingCases.org), funded by the National Science Foundation. The fundamental knowledge units in ES recommended by the study included professional responsibility, basic elements and skills of ethical analysis, and basic elements and skills of social analysis.

The ImpactCS study was no doubt one important input to the design of the proposed Social and Professional Issues (SP) component in Computing Curricula 2001 of the Joint IEEE Computer Society/ACM Task Force on the "Model Curricula for Computing" (ACM & IEEE-CS 2001) which contains a range of ethical and social issues in computing:

SP1. History of computing
SP2. Social context of computing
SP3. Methods and tools of analysis
SP4. Professional and ethical responsibilities
SP5. Risks and liabilities of computer-based systems
SP6. Intellectual property
SP7. Privacy and civil liberties
SP8. Computer crime
SP9. Economic issues in computing
SP10. Philosophical frameworks

In defending the need to include these issues in the computing curriculum, the authors refer to arguments made ten years earlier in Computing Curricula 1991:

> Undergraduates also need to understand the basic cultural, social, legal, and ethical issues inherent in the discipline of computing. They should understand where the discipline has been, where it is, and where it is heading…. Students also need to develop the ability to ask serious questions about the social impact of computing and to evaluate proposed answers to those questions. Future practitioners must be able to anticipate the impact of introducing a given product into a given environment (Tucker et al. 1990).

The picture that emerges in computing is an ethical posture willing to acknowledge the multiple roles of computing professionals (personal, professional, public) and the importance of confronting a broad range of microethical and macroethical issues in research and education. Engineering ethics, on the other hand, its core knowledge having developed from a strong grounding in engineering practice and professionalism, appears less willing and capable of integrating broader social responsibilities of engineers and the engineering profession with considerations of individual behavior and internal relationships of the profession.

Conclusions

Engineering ethics and computer ethics emerged as academic fields in the USA at about the same time (1980s) and for many of the same reasons. Practitioners in these fields became increasingly aware of the social and ethical implications of their work and philosophers began to see these fields as fertile ground for the scrutiny of applied ethics. Despite these similar origins, like twins separated at birth, engineering ethics and computer ethics have been "raised" in radically different environments and thus have developed with different strengths and weaknesses. The notable lack of emphasis on computing ethics in engineering ethics education, despite the predominant role of computing in engineering processes and products, is indicative of the degree of this separation.

The strength of engineering ethics lies in its strong grounding in professionalism and the practice of engineering. In contrast, computer ethics, like computer science, sometimes lacks the professional identity and sense of the practical necessary for the in-depth understanding of ethical problems in computing. On the other hand, the focus of engineering ethics on the personal and professional has resulted in an apparent reluctance to take very seriously the broader social responsibilities of the engineering profession and questions of technology policy in general, issues that most treatments of computer ethics regard as fundamental to the field.

There is thus a need for serious and ongoing dialogue between engineering ethicists and computing ethicists regarding education and research in their fields. Though the differences in the fields are significant, there already exist a number of mechanisms and models for facilitating such an interchange. For example:

- The accreditation of computer science programs in the USA has recently been merged into ABET, the organization that accredits engineering programs.

- IEEE and ACM recently collaborated in the establishment of a code of ethics for software engineers (Pour, Griss, & Lutz 2000).

- Online resources have become a subject of increasing interest in both engineering and computing ethics.

- Organizations such as the Association of Practical and Professional Ethics are well situated to facilitate interchanges between engineering and computing ethicists.

- Professional societies of engineers and computer scientists are in a position to conduct joint conferences on social and ethical issues of relevance to both fields (see for example, Herkert 2002).

While engineering ethics and computing ethics were not really born twins—the differences in their analytical perspectives having existed from the origins of each—the metaphor of twins separated at birth is nonetheless appropriate since there is enough commonality in their origins and current status to facilitate mutual learning to the benefit of both. Indeed a (re)union of the two is long overdue.

Table 1. Microethics and Macroethics in Engineering (Herkert 2003)

<table>
<tr><th rowspan="2">Source</th><th colspan="2">Microethics</th><th colspan="2">Macroethics</th></tr>
<tr><th>Individual</th><th colspan="2">Professional</th><th>Social</th></tr>
<tr><td>Ladd (1980)</td><td></td><td>micro-ethics
professional relationships between individual professionals and other individuals who are their clients, colleagues and employers</td><td>macro-ethics
problems confronting members of a profession as a group in their relation to society (i.e., social responsibility of professionals as a group)</td><td></td></tr>
<tr><td>McLean (1993)</td><td>technical ethics
technical decisions and judgments made by engineers</td><td>professional ethics
interactions between engineers and other groups (e.g., managers, engineers, employers)</td><td></td><td>social ethics
technology policy decisions at the societal level</td></tr>
<tr><td>Vanderburg (1995)</td><td>microlevel analysis
of individual technologies or practitioners</td><td></td><td></td><td>macrolevel analysis
of technology as a whole</td></tr>
<tr><td>De George as reported by Roddis (1993)</td><td>ethics in engineering
actions of individual engineers</td><td colspan="2">ethics of engineering
the role of engineers in industry and other organizations, professional engineering societies, and responsibilities of the profession</td><td></td></tr>
</table>

Acknowledgement

Portions of this paper are drawn from the authors' prior work as indicated in the references.

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Notes

[1] The term "computing ethics" is employed intentionally to avoid unnecessary disciplinary restriction. However, what follows is specifically directed to ethics as taught within or in conjunction with computer science and engineering departments, which is termed "traditional computing". This is due to reasons of economy. While management information science (MIS) and associated disciplines have generated significant ethical scholarship, they are excluded from present consideration as their orientation may reasonably be placed within the theoretically separate framework of business ethics. Software engineering is also developing a separate disciplinary status. While its criticisms of traditional computing closely track those presented here, the numerous political, ideological and theoretical issues affecting its development place its consideration beyond the limited scope of this paper.

[2] The location of mainstream computing within the academic environments of computer science and engineering is not an incontrovertible submission. There are clearly many important initiatives emerging from professional and non-conventional sources. The statement is made for two reasons. First, for most professionals, the academy remains a common and primary source of formal indoctrination. Second, even for those without a formal background, it is a mediator of professional culture through its literature, research and graduates.

Ethical Autonomy and Engineering in a Cross-Cultural Context[1]

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The present discussion poses the question: Is professional autonomy a necessary component of an engineering ethics? The question has some urgency associated with it in the current climate of globalization of engineering practice, since an affirmative answer seems to be a fundamental presupposition of most American scholars of the subject, despite the fact that individual autonomy is not valued as a virtue in some other cultural contexts. In American examinations of autonomy the discussion often revolves around the issue of how the professional autonomy of practicing engineers can be enhanced, for example through the strengthening of avenues for professional disobedience or whistleblowing. Thus, to exercise responsible engineering it is assumed that professional responsibility of engineers sometimes requires challenging the status quo and that all engineers should be aware that they might be put in a position where this is necessary.

In examining autonomy in the context of engineering, however, it is also necessary to recognize a parallel trend, namely the increasing globalization of engineering practice. Not all societies value moral autonomy to the degree that the U.S. does, and in fact some societies positively discourage it for both their citizens in general and in the workplace. It therefore cannot be assumed that in a global climate the question of autonomy can serve as an uncontested universal foundational assumption for building an engineering ethics. In particular, I contrast conceptions of autonomy in Japan and the U.S., and investigate the implications the differences have for specific elements of an engineering ethics. In the following, I will argue that what has occurred is a confusion of the value of autonomy with the goal that autonomy is to achieve. Once this melding is recognized, it can then be asked whether the goals of engineering ethics can be achieved in alternative ways. If this is possible, then professional autonomy is no longer a necessary requirement of an engineering ethics, although in particular societal contexts stressing it may be the best way to achieve its aims.

Looking at the question of autonomy can thus also serve a secondary purpose. It can establish what justifications are appropriately used in developing an engineering ethics. It focuses us on the goals to be achieved through the imposition of special ethical standards for engineers. There exists some intercultural confusion about what the basic framework of an engineering ethics should be and, while clarifying this issue is not the central aim of this paper, it should be noted that the conclusions reached here have normative implications for the structure of a universal engineering ethics.

Global Engineering Ethics

Given the current world situation, it would be difficult to argue that there is not a need for a global foundation for an engineering ethics. Inherited models of localized practice have limited application in a situation where technology almost inevitably has cross border ramifications, even if individual engineers do not directly interact with other cultures. Beyond that, for most engineers in the future their interaction with other cultures will surpass the indirect effects of technological dispersion. Most will have direct contact with other cultures through relationships with foreign engineers in their own culture or through assignments in other countries on a short or long term basis. Multinational corporations have engineers from different cultural backgrounds employed in the same corporate environment, have to deal with subcontractors in different countries, and have to try to adapt their technology for sale and use in numerous different environments. The trends in engineering practice all point to a continued process of global interaction.

Once this is recognized, it must also be understood what barriers stand in the way of globalizing engineering ethics. Foremost among these are the current national interpretations in the setting of standards of practice. A variety of models are in use, ranging from universal requirements for registration, such as in Canada, to no requirement for professional certification, as is the case in Japan. A number of countries and regional associations are now in the process of establishing agreements for cross-border recognition of engineering qualifications,[2] but their attempts are hampered not only by the variety of local standards, but also by a divergence in educational models for engineers and conceptual differences in the terminology used in different societies as it applies to the ethical practice of engineering. Furthermore, it must be considered that in this century societies' increasing reliance on technology is creating unstable conditions and thus is causing uncertainties regarding the appropriateness of new or evolving standards. This makes it appropriate to delve beyond the mere formulation of standards into an examination of their underlying cultural foundations. One of the main contrasts among cultures in this regard is their differing emphasis on the role of the individual in society.

Autonomy and Culture

The ideal of individual autonomy is deeply embedded in the Western philosophical and political tradition. The Socratic dictum, "Know Thyself," forms the cornerstone of this tradition through its emphasis on the self and knowledge. Without further analysis, I will accept the standard assumption that the critical components of autonomy are a requirement for freedom from coercion of thought and action for the individual, adequate knowledge based upon which to arrive at one's own decisions, and the assumption of responsibility by the individual for the decisions he or she has made. The result of this process is independence of the individual's judgment, the value of which has been deemed to be an intrinsic one in the Western tradition.

The value of autonomy, although not necessarily its intrinsic nature, has in more recent times been integrated into the context of professional ethics. Within the framework of the professions, the ideal of the professional was seen as one who acts individually and independently in relation to a client, because it is only the professional who is able to act based on adequately developed knowledge. Due to this knowledge, the professional also assumed the responsibility for the appropriate outcome of professional action. In establishing the model of the professional-client relationship as one where the professional acts autonomously, a paternalistic frame for the professional assuming control over the client's decisions was, however, also established. The more autonomy is ceded to the professional, the less is available for the client. In order that the relationship did not become too dominated by the variable judgment of the individual professional, the professions, in turn, were expected to exercise a control and sanctioning function in relation to the professional. In recent years this model has begun to break down to some extent, with increased demands for client autonomy, especially in the realm of medicine. In fact, in the U.S. at least, the demands for patient autonomy have won out. However, it is noteworthy that while the conflict is described in the literature as one between paternalism and autonomy, it is really one between two different forms of autonomy, professional autonomy and personal autonomy. Not in question at all in the discussion is whether some individual should be making the decision. Even when it is advocated that other physicians or family of the patient ought to be consulted as part of the decision-making process, there is little question that the final decision should be made by one of the two central individuals involved.

The assumption of autonomy so dominant in Western cultural discussions of professional ethics is, however, not a significant feature of actions by "professionals" in all cultures. In part this results from different societal conceptions of the role of the individual, differing societal values, and divergent religious traditions. It is beyond the scope of this paper and outside of its purpose to compare all actual examples of possible variations on the theme of autonomy. Here I will only use Japan as an illustration of some of the important differences from the Western model.

Beyond the theoretical dimensions of these issues, there are good real-world reasons for using Japan as an example in the context of an analysis of engineering practice. During the 1980's, Japan was set out as a model for the future of technological innovation and manufacturing by many Western commentators. While much of the literature has backtracked in the face of a decade long Japanese recession, one result of the admiration is that we know more about the Japanese way of doing things in the field of technology than about any other non-European based country. Furthermore, Japan, through its export oriented economy, will continue to be a dominant player in the process of globalization. Finally, the use of Japan as an example is appropriate because it is currently taking significant steps to imitate the Western model of professionalism, which is not part of its tradition and is, I argue, inconsistent with its societal values.

On a cultural level, Japan is also an excellent example because it strongly exhibits some of the dominant strains found to an extent in many other non-Western models. Japan is a culturally homogenous society, and it takes great pains to remain that way, both through the exclusion of foreigners and the education and socialization of its young. During the Edo (Tokyo) period of the Tokugawa Shogunate (1603-1868), foreigners were totally excluded from Japan with the exception of the trading port of Nagasaki. When Japan "opened up" during the following Meiji Restoration, its slogan was "Western technology with Japanese spirit," emphasizing the continuity of Japanese values. Even today, children who return from extended stays outside of Japan with their parents are viewed as different from other Japanese. When Japan needed foreign workers during its economic boom, the primary source for those workers was descendants of Japanese who had emigrated to South America.

Educational practices mirror this emphasis on uniformity. Students all over Japan study the same curriculum and do so at the same pace. Emphasis is placed on gaining an identical knowledge base and there is great resistance to having a student fail. The high rate of Japanese literacy, the highest in the world, is in large part attributable to this group focus. An important aspect of educational practice is also inculcation into the dominant social values. Children in a class eat lunch together at their desks and are expected to clean up their classroom as a group activity. Students, even of kindergarten age, dress identically when they attend the same school (White 1987).

These types of practices highlight the significance in Japan of group values. A great tendency exists to highlight the group above the self. In many ways, the basic unit of analysis is the group rather than the individual. Social practices are structured to reinforce group standards and behavior. Different schools of flower arranging or tea ceremony are difficult for the outsider to distinguish, because their differences can be so subtle. Within a school, participation means imitating the ways of the master. It has often been argued by Japan scholars that this emphasis on the group comes from the village tradition of Japan, which to a large extent still holds, even in the large cities (Bestor 1989).

This paper is being written during the O-Bon summer festival season, which serves as an excellent example of Japanese cultural tradition. During this period, many firms shut down for a uniform vacation period. The holiday is intended for a "return home" to one's birthplace and family and to honor one's ancestors, and is indeed the busiest travel period of the year. A feature of the season is neighborhood unity and neighborhoods in large cities organize festivals alongside larger ones that cities organize. During these festivals the main public event is an evening o-bon dance where people in traditional, and sometimes nontraditional, costumes dance around a central stage. What is striking to the outsider is that everywhere in Japan people are doing the same dance and that everyone knows how to do it. Participants vary from toddlers to senior citizens and one can visibly see the progress toward standardization with the age of the participants. Most of the dancers are part of organized groups wearing the same clothing, so that subgroups in this larger dance are easily discernible.

The religious foundation of Japan is a complex mixture of Shinto, Buddhism, Confucianism, and Taoism (Earhart 1998). Although most Japanese describe themselves as not being religious, religious practices and symbols like the O-Bon festival form an important underpinning of the nation, in part due to the Imperial family's ancestral connection to the gods themselves. While to an outsider it seems confusing to have a wedding which seems to have both Shinto and

Christian rituals associated with it, based on the clothing and ceremonies involving the bride and groom, to the Japanese it forms part of one identity. On the theoretical level, the most dominant religious practice is Buddhism, given the lack of a doctrinal foundation of the native Shinto. As the Buddha saw it, the aim of life is to reduce suffering by eliminating the notion of the self (Sanskrit *anatman*). Destruction of belief in a self or ego meant release from the pain induced by the world. This lack of emphasis on the self forms an enduring part of the Japanese tradition. While 'I' is one of the most common words used in English, overuse of the equivalent in Japanese (*watashi*) indicates a lack of character. As Hyakudai Sakamoto puts it: "One theory holds that the word *watakushi* originates in *wa-tsukushi*, which means "I annihilated," or "myself eliminated." *Wa-tsukushi* is a way of identifying the self in most minimal fashion" (Sakamoto 1993, p. 11). The classic Japanese saying, "The nail that sticks out will be hammered down," accurately reflects the social picture.[3]

Professional Autonomy Justified

The contrast between the emphasis on individualism in the American tradition and the Japanese emphasis on group values in the social order has been well recognized in the literature and the above discussion breaks no new ground.[4] I now want to investigate the implications of the differing societal structures for the domain of engineering ethics. The discussion makes evident that it is difficult to divorce the technological enterprise, given that it is a human activity, from its surrounding societal context.

It is by now the generally accepted perspective in the U.S. that professional autonomy is a cornerstone of responsible engineering practice. As Martin and Schinzinger put it in their groundbreaking text on engineering ethics, "the study of engineering ethics aims at empowering individuals to reason more clearly and carefully concerning moral questions, rather than to inculcate any particular beliefs. To invoke a term widely used in ethics, the unifying goal is to increase moral autonomy" (Schinzinger & Martin 2000, p. 14).[5] Although the concept of engineers acting as individual agents with corresponding responsibility and accountability did not originate with engineering, but rather with the individual medical practitioner, it has a special relevance for the practice of engineering, due to the special pressures which face the typical engineer. Even though the medical profession's paradigm of individual practice may be changing as medicine adopts a corporate culture, that paradigm has firm historical roots. For engineering, on the other hand, the model has been an ideal imposition on a very different historical picture. About ninety per cent of American engineers are employed by corporations. The ideal of individual practice was never much more than that, an ideal, but it was seen as a necessary one if engineering was to be elevated to true professional status. For example, early codes of engineering ethics referred exclusively to clients rather than the current phraseology of "employer or client." This is due to the generally accepted assumption that there is an inherent conflict between the fundamental values of a profession and of business. As most engineering codes of ethics highlight, "Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their duties."[6]

The primary professional responsibility of engineers is thus seen as being the guarantors of public safety in the development, use, and spread of technology. Business, on the other hand, based on the neo-classical capitalist model, operates based on the assumption that the forces of the market and appropriate governmental regulation will protect the public, and that within that framework corporations should make decisions based on their own perceived interests. The establishment of engineering as a profession can thus be viewed as an additional safeguard for the public, with the responsibility of protecting the public in the face of opaque technology. The professional model applies in that it is assumed that the public is unable to understand the complexity of technology and is unable to make sound independent decisions in relation to it. The implication is that in relation to technological development some form of paternalism is necessary. I believe this to be a fundamental difference between engineering and other professions, which are moving away from paternalistic perspectives to a focus on client autonomy. In a way, in moving toward increased professionalization, engineering has implicitly taken the opposite tack of developments in other professions. Given what is at stake in engineering processes, this may be a necessary feature in a technologically complex world. This is the case because in engineering it is society as a whole which is the true client, rather than simply one or a few individuals who are the clients of the practitioner in the more typical professions (Luegenbiehl 1981).[7] Technology has the potential for wide ranging, long lasting, and irreversible impacts and consequently engineers must assume a special responsibility for ensuring that the public is kept safe as a result of their design decisions.

In order to give some coherence to this claim in light of the Western emphasis on the individual's autonomy, it is important that the distinction between the value of autonomy and the value of professional autonomy be kept in mind. There is a clear difference between some role that an individual might have as a participant in society as a citizen and the role of the individual as it requires professional autonomy. In the role of the citizen, the justification for autonomy might occur on two levels. One is the Kantian notion that individuals are by their very nature as rational beings deserving of autonomy. The other is a more politically inspired perspective which holds that individual autonomy is necessary for the proper functioning of society based on an ideal of liberal democracy. In terms of professional ethics, neither one of these justifications directly applies. In fact, it is generally argued that a key potential conflict is between the duties of the professional as a professional and her or his basic moral beliefs, such as in the case of refusal to follow a hierarchical superior's instructions. While this is not the place to explore this conflict, it should be noted that the resolution of it forms one of the more contentious elements of debate in professional ethics. What is clear from the debate, however, is that it is recognized by most parties to the debate that this potential conflict between professional ethics and personal ethics exists (Harris, et al. 2000). I hold that this is based on the fact that the justification for the two is not the same. Professional ethics, as a role ethics, is ultimately based on the justification of protection of the client. In the case of engineering, the ethics codes make the assertion that this is the public as a whole. Now it might be argued that, analogous to the Kantian perspective, there is something inherent in the notion of professionalism that requires autonomy of the professional, but to my knowledge no such argument has been put forth, only the position that autonomy is required for the appropriate performance of an engineer's duties in light of the potential conflict with managerial orders.[8]

Professional autonomy is then appropriately justified based on the goal for the accomplishment of which a profession has been established in society. Briefly put, the goal of engineering is to design, develop, and implement technology. The role of engineering ethics within that context is to ensure the protection of the public's safety, health, and welfare in the process. This can be further seen based on two points. First, a number of engineering codes of ethics include the notion that enhancement or advancement of humanity should be established through engineers' work to benefit humanity in a positive sense. For example, a proposed model code of engineering ethics says engineers shall "endeavor to direct their professional skills toward conscientiously chosen ends they deem, on balance, to be of positive value to humanity; declining to use those skills for purposes they consider, on balance, to conflict with their moral values" (Unger 1994, pp. 110-24). Again, the difficulties inherent in establishing this requirement prevent further discussion here, but the key is that it makes clear that the work of engineers is seen as being governed by designated goals. Second, codes of ethics and the discussion of ethics in engineering more generally, are only peripherally designed for the benefit and protection of the individual engineer. Some halting attempts have been made to establish a set of rights for engineers, but these have not seen much additional development (Whitelaw 1975). When rights are discussed in engineering texts, these are in the main rights applicable to all employees rather than strictly rights of professionals. A significant exception to this is the notion of the right of professional dissent, culminating in the right or obligation to blow the whistle, but here again the justification by the individual has to be based on the ideal of protecting the public.

I take it then that if professional autonomy is justified, it is not justified based on some ideal of autonomy in general, but rather based on the need of autonomy for the engineering profession to properly carry out its agreed on task in society. Based on a contract theory of the professions, an implicit agreement exists between an occupational group and society through which a profession is delegated by society to carry out one of its specialized functions. This function requires a high degree of skill and an extensive theoretical and applied knowledge base. The occupational group accepts certain restrictions on its activities and the role of guaranteeing that the function will be carried out in an exemplary fashion. In return, the occupation becomes a profession and is granted a high level of prestige and a relatively secure living for its members. In part this is typically achieved through the granting of monopoly power to the profession. The profession controls educational requirements for entry, entry itself, and continued participation in the profession. It does so through its licensing power, which is most often structured through society in the form of governmental control, but with the clear control by the profession itself in that members of the profession draft the actual rules. While the professions claim that this is intended to guarantee the work done by its practitioners, others see more sinister motives of self enrichment, but that is clearly not the theoretical justification for the existence of the professions (Luegenbiehl 1983).

What we have then is a theoretical justification for the autonomy of the professions based in the need for deciding on adequate and enforceable standards of practice. It should be noted that there are practical difficulties in applying this model to engineering in the U.S., since engineering there does not have monopoly power. Less than twenty per cent of U.S. engineers are licensed and the remainder therefore does not fall under the regulatory scheme of engineering as a profession. Most engineers, or people designated as engineers by their employers, are covered by what is known as the industrial exemption, whereby one engineer is able to sign for the work of another. This means that the profession lacks control over entry, over the work that engineers are to perform, and lacks disciplinary power. Most of all, it lacks control over who is able to represent themselves as an engineer. However, in practice engineering has been relatively successful at achieving a degree of prestige and compensation commensurate with professional status. This may, however, be more due to the dependence of contemporary society on technology than due to the influence of the profession. Thus most engineers and most of society think of engineers as professionals, but perhaps in a rather confused sense, since the individual autonomy of engineers tends to be restricted by their employment context.

Nonetheless, it is the model of professionalism which guides the ideal of social responsibility inherent in engineering and in its codes of ethics. In terms of the theoretical model, though, the professions need to provide an additional justification for the transfer of the autonomy granted to them by society to the individual practitioner. This is provided for by the claim that no one outside of the profession is in a position to judge the quality of the practitioner's work. Given the employment context of the engineer, she or he will be surrounded by people lacking engineering education and consequently subject to making decisions based on non-engineering criteria, often economic ones, which they will consider to be more telling than engineering ones. Perhaps the most famous quote in this regard comes from the Challenger space shuttle case, where the engineering manager, Robert Lund, is told by his superior during a crucial pre-flight certification conference: "Take off your engineering hat and put on your management hat" (Boisjoly 1993, p. 63). The role of the profession in relation to the professional is to be the guarantor and judge, but also the protector of the engineer. The profession guarantees the individual's work to the outside world, often in the form of an imposed code of ethics of practice, and simultaneously sets itself up as the enforcer and ultimate arbiter of its rules. Autonomy on the individual professional level is a means of protecting both the professional and the profession against the forces of external ignorance and potential greed.

What this discussion makes evident is that the autonomy of individual engineers or professionals in general is not directly derived from moral theory and claims about human autonomy found there. Few would argue, for example, that moral autonomy justifies the actions of the roofer or the house painter in relation to her job. Competence in the case of the engineer, unlike that of some other workers, has a moral dimension. This is based on the special implications the work of professionals has for human life. That is not to say other occupations have no impact on lives, they all do, but the professionals' work has a special, sophisticated, set of competencies associated with it that other occupations do not. And that is part of what justifies viewing engineering as a profession, even though some of the essential traits appear to be missing in the societal grouping in the U.S.

Once it is accepted that professional autonomy is not equivalent to the moral autonomy of the Western tradition, although it has moral dimensions, it can then be asked whether professional autonomy is an essential ingredient of professional practice. Here I would like to reformulate the inquiry in terms of the purpose for which the professions exist. That purpose, as previously indicated, is to carry out some special function in society. In engineering, as the ethics codes assert, it is required that the function be carried out while holding "paramount the safety, health, and welfare of the public." However, in conducting the inquiry it is extremely important that the context of engineering be kept in mind. The analysis above was carried out in light of two conditions: a history of professionalization of occupations in the West and an employment environment of neo-classical capitalism. But these two conditions do not hold everywhere in the world. And thus it must be asked whether autonomy at either the level of the profession or the individual professional is a universally needed requirement, for if it is, then major cultural changes in some parts of the world will be necessary for engineers to function ethically in those societies.

The Japanese Model

In Japan, as our proposed alternative example, neither one of the above two conditions holds. Japan does not have a tradition of professions and it does not in general advocate a classical capitalist model. Further, as has already been proposed, it has no high regard for individual autonomy. It thus serves as an excellent point of contrast in terms of the main elements of the U.S. model. Other societies will exhibit varying degrees of divergence in terms of these elements and should be examined individually as well. In looking at the Japanese example, since the main subject is the requirements of an engineering ethics, I will restrict myself to examining the context in which most engineers are employed, that of business.

It has already been shown that the educational and socialization practices in Japan emphasize the group above the individual. In the context of business, the educational practices seem specifically designed to further this emphasis. Traditionally, although this has begun to change in the last few years, Japanese corporations hire incoming college graduates once each year, and all begin training at the same time. Employees are selected more based on the college from which they have graduated and based on their professor's connection with a corporation, than based on their major or class standing. "The general view is that university is a well-earned four-year vacation between adolescence spent in "examination hell" and a future lifetime of regimented employment" (Bieniawski & Bieniawski 1996, p. 194). While some critics have argued that a weakness of the Japanese educational system is that students, after years of preparing for the difficult entrance examination for university, relax during their college years and are almost assured of graduating, corporations are complicit in the system because it allows them to undertake the necessary training themselves. As one report on engineering education in Japan put it:

> Evidently, from the perspective of industry, the definition of a quality graduate is markedly different in Japan and the U.S. In the U.S., a "good" graduate, among other characteristics, is defined as one who will be immediately useful to the company, has graduated with high marks, and has relevant work experience. In Japan, a "good" graduate is one who is flexible, fits in well with the company (trainable), and has proven their potential in the harsh entrance examination by attending a prestigious university (Yamada & Todd 1997, p. 344).

Employees thus come to corporations relatively unformed, with the exception of belief in group coherence, which has been reinforced during the college years by the tremendous amount of time devoted to a "club" which most students belong to, be it a sports team or a hobby group.

Once graduates are hired, the corporation reinforces group dynamics. Employees are encouraged to bond with fellow workers hired during the same year. All university graduates, including engineers, receive approximately the same salary for a number of years and subsequent raises are seniority based. At the same time employees are encouraged to identify with the corporation as a whole by way of rotation through various departments. This also discourages feelings of being a specialist in a particular practice (Kinmoth 1989). All of these factors work together in a system of lifetime employment in the large corporations, where employees in a corporation feel closely dependent on each other and on the corporation.[9] Lifetime employment makes possible what to many American corporations would seem to be practices wasteful of their financial resources. Because employees will work together for their entire career, the ideal of group harmony (*wa*) becomes a guiding virtue in the Japanese corporation as it is in Japanese society as a whole.

Even this brief introduction is enough to show that professional independence would be very difficult to establish in such a corporate system. The new employee is inculcated with the values of the corporation. His or her first loyalty is to the corporation, not to some abstract notion of profession. When Japanese employees are asked "What do you do?," the typical answer is something like "I am a Mitsubishi man," not "I am an engineer." "The degree to which the Japanese identify with their employers is generally so strong it prevents them from having or developing any interest or links with others in their profession. In many professions, members of different organizations do, in fact, avoid communicating with each other" (DeMente 1981, pp. 62-3). "Professional society meetings, conferences, and continuing education programs are normally considered an important part of career development in western countries. The average Japanese engineer does *not* participate to any great extent in professional activities. Instead, most efforts are devoted to the company's goals" (Heidengren 1992, p. 122). Given this emphasis on identification with the employer, Japanese engineers have a difficult time even thinking about the idea of whistle blowing. In conversations with them, while they understand my use of the concept, they do not grasp why it would ever be necessary to engage in such an action, since they identify so closely with their employer. As one Japanese engineering professor with extensive industrial experience puts it, "Informing outsiders of confidential information has been taken as betrayal to the organization and colleagues. Whistle blowers are perceived as untrustworthy and would not be accepted by Japanese society. No appreciation by the public is expected to a specific whistle-blower as seen in the U.S" (Iino 2001, p.8D2-39).

Japan lacks a tradition of profession and professional identification and therefore the associated emphasis on professional autonomy. While in medieval times the system of family centered occupational tradition had some similarity to the European guilds in a hierarchical feudalistic system, with the industrialization of Japan in the second half of the nineteenth century the idea of group loyalty was transferred to the context of work rather than to an external body accrediting the quality of work. A basic aspect of the emphasis on the group in Japan is the distinction between being inside and outside (*uchi/soto*) of the group. It is the internal ties of the group which to a large extent determine actions, not adherence to some abstract principle. Loyalty and selfless devotion are the determinants of action.

The major historical groups for the Japanese have been family (*ie*), local community (*mura*), the corporation (*kaisha*), and the nation. Since the beginning of industrialization in Japan, as Taka and Foglia assert, "*kaisha* has taken over many of the functions of *ie* and *mura*" (Taka & Foglia 1994, p. 137). The identification with being Japanese (*nihonjin*), however, remains strong. The world of the *gaijin* (foreigner) always remains outside. "The Japanese/outsiders distinction is central to a Japanese identity, and blurring the divisions poses a threat to a Japanese definition of the world" (Yamada 1997, p. 140). In looking for guidance for action, the Japanese engineer will thus typically act in terms of the sense of the group, not a group of professional engineers, but the fellow members of the corporation. The guidance, in turn, is typically consensus based after an extensive process of informal consultation (*nemawashi*). This has led Scott Clark, after an extensive anthropological investigation of the ethics of engineers in Japanese corporations, to arrive at the conclusion that "engineering ethics in Japan is founded upon building and maintaining positive relationships." (Clark 2000, p. 20) Mutual trust and the need for harmony thus override individual concerns and lead to a lack of individual autonomy, with important ramifications for engineering ethics. "Put in another way, because the loyal employees generally try to do what seems to be good for the corporations, issues such as manufacturing defective products or stealing the firm's assets have not been earnestly discussed in Japan" (Taka and Foglia 1994, p. 139).

Consideration of the inside/outside distinction raises the second feature relevant to this discussion, that of the corporation's identity. On the neo-classical capitalist model, the corporation sees its primary obligation to the owners, the stockholders. In the Japanese model of developmental capitalism, on the other hand, the aims of the corporation are closely identified with the aims of the nation. A primary function of the corporation is to help society advance, rather than serving the immediate desires of the stockholders (Gilpin 2001). Japanese are the inside group, while everyone else is outside. The other major function of the corporation, in accordance with the above analysis, is to remain in existence, to provide a continuing source of earning a living for its employees, just as a family would assume continuing responsibility for its members (Lauenstein

1993). This ideal has been made workable in part by a system of interlocking corporate ownership (*keiretsu*) which allows corporations to take a longer term outlook. It also explains what from a Western perspective seems to be very little regard for the ordinary citizen's needs. The bond between the industrial complex and government holds that the furthering of national interests takes precedence over the private needs of the public. Until very recently, there has been no consumer movement in Japan. "Influenced by the press and by its sense that the achievements of Japanese industry are the achievements of the nation, the Japanese consuming public is uncritical and supportive" (Prestowitz 1988. p. 176).

The relationship between government and industry has been continually strengthened since the 1950's through an industrial policy implemented by way of a system of administrative guidance. Government directs and "guides" the corporations according to its vision of the national interest, and corporations, despite some significant exceptional cases, have generally followed the directives, even to the extent of cooperating with rivals in the same industry.[10] The primary instrument of guidance for industry has been the well-known Ministry of International Trade and Industry (MITI), which was recently renamed METI (Ministry of Economy, Trade, and Industry). METI has "near-monopoly power" in its area of responsibility. "Among large industrial states, few, if any, bureaucracies exercise comparable power over the sector-specific management of the industrial economy" (Okimoto 1989, p. 112). Lest it be thought that this makes for a unidirectional system of command, it is important to keep in mind that consultation and consensus building occurs in the relationship between METI and industry just as it does internally to the corporations. Japan thus has not only a sense of common purpose for its technological future, but also a means of attempting to manage that future.[11]

Compatibility of Models

The relevant contrast that we find between the U.S. and Japanese situations for engineers is then as follows. The ideal professional model requires that the engineer and the engineering profession be autonomous so as to protect the public in the face of corporate self-interest. The ideal Japanese model, on the other hand, requires the engineer to function harmoniously as an integral part of the group in a system where the corporation serves the needs of society. The potential for professional autonomy is very limited in the Japanese model. In the Western model the profession guarantees the quality of the engineer's work through its contract with the larger society. In the Japanese model the corporation serves the same function.

One way of seeing this is in the process of taking responsibility for actions. Western observers are sometimes puzzled by the way corporate heads in Japan take responsibility for actions of subordinates. If there is wrongdoing by employees in a U.S corporation, the job of the executive is to get rid of the wrongdoers. If the executive has to take responsibility, it is because he or she should have exercised a neglected supervisory function. In other words, the executive was not doing his or her job properly. In the Japanese system, on the other hand, the executive will often resign or submit to other sanctions, including abject and 'sincere' apologizing, as a symbolic representation of the corporation as a whole taking responsibility for the action. In a sense, when an employee does wrong, the whole corporation does wrong or is responsible. While this has sometimes been interpreted as the avoidance of responsibility (Clark 2000), it is more useful to interpret is as a form of collective responsibility. Akito Morita, the founder of Sony Corporation, has been quoted as saying that "the company is a fate-sharing vessel" (Schoppa 1985, p. 12). Hiroshi Honda uses the case of a subsidiary of Toshiba Corporation selling technology to the former Soviet Union, in violation of international agreements, which had the potential to make submarines too quiet for detection. The case became famous in the U.S. when members of the House of Representatives used sledge hammers to destroy Toshiba radios on the steps of Capitol Hill (*Newsweek* 1987, p. 40). As Honda puts it: "The chairman and the president of Toshiba resigned, even though the home office had not been involved in the affair" (Honda 1992, p. 31).

Seen in terms of engineering, it is therefore the corporation which takes responsibility for, and guarantees, the engineer's work. The engineers, for their part, are an integral part of the larger group and, knowing that their fate is tied to that of the corporation, would be aware that they would not profit from individual actions. The corporation, in turn, sees its interests tied to those of the nation. The core demand for "the safety, health, and welfare of the public," the primary goal of an engineering ethics, can then be achieved through the corporation, since it is not expected to act based solely on the interests of its owners. Put another way, the stockholders see themselves in the same "fate-sharing vessel" as the other members of Japanese society and are therefore able to take a self-sacrificial perspective. "Buy American" campaigns in the U.S. have been notably unsuccessful because U.S. consumers will gravitate toward the best product at the lowest price. Japanese, on the other hand, have accepted high food and transportation expenses, as well as "rabbit hutch" housing, because they have been persuaded that the national, and therefore their own, interest lies in an export driven economy.

It is interesting that in his research on Japanese engineers Clark found that "nearly every engineer that spoke of safety considered it as part of the quality of the product" (Clark 2000, p. 25). While an American company might well say that product safety is a feature delegated to its engineering staff, it would make no such assertion about quality. Quality and safety are separate aspects of the product. In taking a holistic approach to the product, the Japanese engineers are reflecting the integrated nature of all the divisions of the corporation. One of the findings of comparative studies of American and Japanese engineers has been that American engineers want to be design engineers and do not assign as much prestige to jobs in manufacturing, quality control, and sales. No such distinction is evident among Japanese engineers. There is, instead, an emphasis on the priority of production, with an integrated perspective on the different phases of the engineering process (Imai 1986). The identity of the engineer is found in the corporation as a whole, not in one of its specific divisions, nor in any specific job description.

Autonomy is an essential ingredient of Western conceptions of professional ethics. The need for autonomy is generated by the work environment of the engineer, where the public safety is liable to be threatened by the economic imperatives generated by management, which is itself responding to pressures from its stockholders. If the conception of the societal responsibilities of the corporation is different, as it is in Japan, then the control function exercised by engineering autonomy is not as evident. If, further, the engineers and others in the corporation perceive themselves to be in a mutually interdependent relationship, then an emphasis on autonomy will not be the most appropriate way to achieve the goal of engineering ethics. As a consequence, in one engineering environment autonomy may be appropriately emphasized, and may need to be promoted in order that the societal purpose of an engineering ethics is achieved, while in another it need not be and its emphasis could actually be counterproductive.[12]

The result of this analysis should not gloss over the fact that there can be, and indeed is, ethical wrongdoing by Japanese corporations, just as there are American engineers who misuse their professional autonomy. In fact, of late Japanese corporations have been subject to especially heavy public scrutiny, particularly because of safety issues that have arisen in the nuclear power industry. Hiroshi Iino cites these and a number of other cases, including a case of contaminated milk products and a Mitsubishi cover up of customer complaints about defective products over a period of twenty-five years. (Iino 2001). However, the relevant question is not whether ethical wrongdoing would occur in a particular environment where professional autonomy is not emphasized, but rather whether autonomy itself is a proper foundation for a global engineering ethics. Wrongdoing by some individuals is an inherent feature within any ethical system and therefore pointing to instances of it is not a valid indicator of the superiority of an alternative model, in this instance of the model of professional autonomy. Given the divergence of cultural preconceptions regarding the value of autonomy, it is instead imperative that a global model for engineering ethics be sought which does not require reliance on autonomy as the foundation of engineers' ethical responsibilities.

Conclusion

The position advocated in this paper is that it is a mistake to rely solely on the Western philosophical tradition to justify "professional ethics." The work of "professionals" has a special role in society. Differing ethical requirements may be compatible with that role in different societal contexts. Therefore, professional ethics cannot simply be the subject of abstract philosophical analysis. It needs to be looked at in the context of particular cultural domains. This makes the development of a universal engineering ethics, which I believe is a necessary element in the future of engineering (Luegenbiehl 2003), a much more difficult proposition than if one could simply base such an ethics on a particular tradition of moral theory. It will instead require each culture examining the individual propositions of such an ethics in light of a universal goal of the protection of the public safety.[13]

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Notes

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[2] The primary example of this is the Washington Accord, signed in 1989, which recognizes the substantial equivalence of engineering qualifications of graduates of accredited programs in member countries. Since some of the countries have ethics education requirements in their accreditation standards, the Accord has implications for the development of ethics standards internationally. However, the signatories are limited to the United Kingdom, the United States, and a number of English language dominated countries with close ties to Britain. Japan became the first non-English speaking country to become a provisional member of the Accord in 2001. A similar agreement is being developed by the APEC (Asia-Pacific Economic Cooperation Forum) engineering project.

[3] I want to emphasize that all of the discussion regarding Japanese society should be taken in light of the fact that it is also a society in flux, a dynamic society, where tensions exist between progressive and conservative forces. The visitor to Japan, for example, will notice that many Japanese are dyeing their hair in various colors to distinguish themselves from the uniformly black hair provided by nature. Commentators have variously accounted for phenomena such as this as indicating a permanent change in Japanese culture toward increased individuality, a youthful phase which will be absorbed as the young need to function in mainstream society, or a superficial feature which does not impact the enduring values of Japanese society.

[4] For a more complete review of the contrasts between the two cultures' values see, for example, the classic work by Nakane (1970) or Smith (1983).

[5] The first version of this text, titled *Ethics in Engineering*, by Martin and Schinzinger was published in 1983 and was the first text on engineering professionalism co-authored by a philosopher.

[6] For example, the Code of the National Society of Professional Engineers on the 1947 version of which most other engineering ethics codes of technical societies in the U.S. are modeled, although as time passes amendments to the societies' codes is resulting in some divergence among them.

[7] It should also be noted that paternalism may have various strong and weak forms, so that it may include consultation with the public regarding potential technological developments.

[8] The literature on whistleblowing in engineering is extensive. For a representative example on the need to protect the public see Martin (1992). More recently, some opposition to whistle blowing has emerged in the literature, with Michael Davis the primary analyst (Davis 1996).

[9] Again, it should be noted that due the extended recession in Japan, which began in 1991, starting in the mid-90's some corporations have begun to move away from the lifetime employment system, but only with great reluctance. See *The Japan Times* (1996) The strength of the ideal is demonstrated by the indirect methods, such as placing workers into positions with no duties, used to attempt to eliminate workers and workers' resistance to such methods, which are an extension of the more traditional Japanese tactic of having nonproductive staff "sit by the window." See, for example, *The Wall Street Journal* (1999).

[10] This cooperation should be seen in light of the fact that the Japanese are known to be fierce competitors within industries, in constant competition for market share. The inside/outside distinction applies to the relationship among corporations as well.

[11] It has been widely debated how successful the work of MITI has actually been in providing for Japan's industrial success and the degree to which other factors are actually responsible. Entering that debate would be outside the scope of this paper.

[12] In light of this conclusion, it is somewhat worrisome that there seems to be a push for the adoption of American codes of ethics worldwide. The National Society for Professional Engineers (NSPE), for example, reports that its code is being translated into a variety of languages and that the opinions of its Board of Ethical Review have been licensed to the Japan Consulting Engineers Council. See NSPE *Engineering Times*, December 2000. With the establishment of the Japan Accreditation Board for Engineering Education (JABEE) in 1999 it is expected a code very similar to American ones will soon be adopted.

[13] As a caveat, it should be noted that the ethical autonomy of the engineer may have functions other than the protection of public safety. That issue is left for another paper.

Investigating Professional Responsibility

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In this paper I will discuss two approaches to the investigation of professional responsibility. The term "applied ethics" is often used to mean either, or both, what I and many others in the U.S. call "practical ethics" as well as what is called "applied ethics." However, the terms "practical ethics" and "applied ethics" are also used as names for two philosophically distinct approaches to scholarship on professional ethics and other areas of ethics that deal with specific moral questions or problems. I confess to being an advocate of the practical ethics approach, but my goal here is not to convert you from speaking about applied ethics to speaking about practical ethics. Rather, it is to make clear how the two different approaches affect the nature of scholarship in professional ethics.

I begin by briefly describing the emergence of scholarly work on the subject of professional ethics that began in the late 1960s and '70s in the U.S. I apologize for opening with a U.S.-centered story, but trust that much of the later argument in this paper about both professional ethics in general and engineering ethics in particular will be widely applicable, especially in technologically developed democracies.

The emergence of scholarly work on the subject of professional ethics is a useful starting point because many writers on engineering ethics are scholars in the humanities and social sciences, rather than engineers, and it behooves us to look critically at our own disciplines and how they may distort the understanding of engineering ethics as well as contribute to it. Scholars may find the story of the response of analytic philosophy to the emergence of professional ethics instructive for what it reveals about the features and foibles of our disciplines and how they can influence what we see and overlook in science and engineering ethics.

The Possibility of Professional Ethics as a Scholarly Field

In the early 1970s, when significant numbers of philosophers began to participate in the conversation about professional ethics, some had qualms about it and denied that professional ethics could be a valid domain of scholarly investigation. Those who were skeptical about making professional ethics a domain of philosophical investigation said that rules enjoining honesty or promise keeping are the same whether one is a physician, a lawyer, or a bricklayer.[1] (On one level this assertion is trivially true, but it does not take into account the differences among professions as to what one must attend to and the pitfalls one must avoid in deliberating about how to be honest or keep promises.) This assertion was just a corollary of the view that ethical norms are timeless (rather than enduring) and apprehended by reason alone and in abstraction from any social context. (There were some squabbles between the consequentialists and the deontologists about just what timeless principles reason dictates, however.) It was a legacy of strong and consistent influence of Kant and the Utilitarians, and the Enlightenment faith in reason that they exemplified. (The early Twentieth Century saw the development of the intuitionist form of consequentialism.)

The tendency to assume that philosophy dealt with timeless propositions strengthened when, soon after World War I, Logical Positivism (and later, Logical Empiricism) became a dominant view in epistemology. Although the tendency to equate reasoning with deductive reasoning had had a long history in philosophy, deductive logic took on a new prominence in Logical Positivism. Deductive logic, after all, seemed clearly a part of philosophy and not in danger of becoming a separate empirical discipline, as had the previous branches of philosophy that became physics and psychology. At the same time, deductive logic was close enough to mathematics to be immune from the charge of being merely speculative. Only after the shock of the Gödel incompleteness result and the failure of the Hilbert program, was philosophy gradually weaned away from the illusion that deductive logic was the heart of philosophy.

Ethics was the field of philosophy most distorted by this trend, which at the extreme even briefly saw the emotivist view of ethics, according to which what purported to be ethical judgments were not judgments at all, but only expressions of feeling (A.J. Ayer) or attempts to persuade (C.L. Stevenson). It may come as no surprise that when philosophers again recognized ethical judgments as judgments, they sought to construe them as much like logical truths as possible. This tendency often rendered them blind or indifferent to practical deliberation However, many Aristotelian, feminist, American Pragmatist, Marxist and Thomistic philosophers questioned the hegemony of Enlightenment attempts to found ethics on one or more principles given by reason alone—which hereafter I shall refer to as "rationalist foundationalist" moral theory (whether consequentialist or deontological)—and the consequent tendency to neglect moral deliberation in favor of moral criticism.

At mid-century, Stuart Hampshire argued that moral philosophy had gone astray by representing reason as deductive reason and thus neglecting practical *deliberation.* He argued that philosophy had neglected Aristotle's distinction between theoretical judgments and practical judgments, such as those about what would be a good thing to do in a given problem situation. He also argued that philosophers had misunderstood the task of philosophical clarification, had erred in assuming that all literally significant sentences must describe, and had mistakenly concluded that because moral judgments are not *logically entailed* by statements of fact that statements of fact cannot *form the basis for* moral judgments. He argued that the bifurcation of fact and value judgments had encouraged the neglect of deliberation, which always considers factual judgments in concluding what would be a good (or even "the best") thing to do in some circumstance (Hampshire 1983).

Nine years later, in "Modern Moral Philosophy," G.E.M. Anscombe (1958) argued for some of the same conclusions in her trenchant and thoroughgoing criticism of philosophers from Hume and Kant to Henry Sidgwick to the "Oxford objectivists" (intuitionists) of her own day. Like Hampshire, she went back to Aristotle's conception of ethics and argued for adequate attention to deliberation that did not misrepresent it as a deduction from theoretical principles. However, she took a further step in challenging the continued use of the notion of moral obligation on the grounds that it is a holdover from Judeo-Christian ethics based on divine law that could not stand on its own. Anscombe held that the attempt to base obligation on conformity with supposedly timeless abstract principles was part of the whole mistaken view of ethics that neglected deliberation and which, she argued, led to moral corruption. It leads people to *calculate in advance* circumstances in which they might be justified in performing some great wrong, such as procuring the judicial murder of an innocent person. I take Anscombe to be drawing attention to how such calculation hardens people to the thought of doing a great wrong.[2]

In the 1980s, such works as Alasdair MacIntyre's *After Virtue: A Study in Moral Theory* (1981), Bernard Williams's *Ethics and the Limits of Philosophy* (1985) and Annette Baier's "Extending the Limits of Moral Theory" (1986) voiced renewed doubts about rationalist foundationalist approaches to philosophical ethics and the attendant reliance on deductive reasoning from abstract principles in U.S. philosophical circles.[3] By this time, practical and professional ethics had already taken on a life of its own.

Medical Ethics as an Example of Professional Ethics

Professional groups had not waited for philosophers to get around to recognizing professional ethics as a scholarly field. Many professions—medicine, nursing, and engineering, in particular—had had a long history of ethical reflection on professional norms by the time philosophers joined the conversation in significant numbers in the 1970s. The consumer rights movement in the U.S. had helped to spawn the patient rights movement, which was a further influence on the emerging conversation in medical ethics and one that helped bring it widespread public attention.

The medical profession had a long, if discontinuous, history of ethical reflection. In the 1970s (before most of them became employees of hospitals and health maintenance organizations), U.S. physicians enjoyed a very high status and income—I recall at that time one German-trained physician who had come to the U.S. telling me that she had come to understand that in the U.S. "M.D." stood for "minor deity." This high status helped to ensure that even those philosophers who sought abstract universals in ethics paid some attention to physicians' experience when they wrote medical ethics.

However, the history of medical practice developed in parallel with philosophy of medicine and bioethics, and only occasionally informed the early development of bioethics. Abstract principles still influenced philosophical bioethics in the early 1970s. The views of John Rawls were becoming increasingly influential in philosophical ethics in the 1960s and 1970s just as the field of bioethics was emerging. In his 1957 article, "Outline of a Decision Procedure for Ethics" in the influential journal the *Philosophical Review*, Rawls (1957) had sought to define for philosophy a significant role as ethical arbiter. He suggested that the business of philosophical ethics is to address ethical problems by formulating applicable ethical principles and ordering them so as to decide which takes precedence in case of conflict. In 1971, in his major work on social justice, *A Theory of Justice*, Rawls (1971) elaborates his position as being that for very general principles of justice, the ordering is serial so that one must satisfy a prior principle before considering satisfaction of the next principle.

In their 1979 book, *Principles of Biomedical Ethics*, Tom Beauchamp and James Childress (1979) took up the task of formulating principles. The intuitionist W. D. Ross (1930) had proposed his "principle of non-maleficence" in 1930, and Beauchamp and Childress adopted it as one of their four "principles of biomedical ethics." This principle bears some resemblance to the physicians' *empirically based moral rule* "First, do no harm", but they are not looking for an empirically based moral rule, but Ross's abstract principle, as their jargoned name for it reflects (Jonsen 1977). Had they been looking for experienced-based rules they could not have failed to notice that the successes of twentieth century medicine changed the presumption about doing harm. Treatments such as chemotherapy, which poisons patients in an attempt to kill the cancer cells before killing the rest of the patient's cells, have hardened medicine to doing harm in the hope of bringing about a dramatic improvement in health outcome. (Of course, some have suggested that medicine has gone overboard in providing aggressive measures that do harm.) Rather than recognizing an obligation not to harm, contemporary medicine recognizes an obligation to refrain from taking particular risks or imposing harms that the patient forbids (See Whitbeck 1985; 1997a; 1997b).

That the principle of non-maleficence was retained despite the change in the actual norms of good medical practice reflects the persistent tendency in some circles to ignore the arguments of Hampshire, Anscombe, and others and to proceed by continuing to develop abstract principles and subsume cases under them, either ignoring the process of deliberation or misrepresenting it as deductive reasoning.

At nearly the same time (1978), the first edition of the *Encyclopedia of Bioethics* appeared and provided an influential reference work with a diversity of philosophical perspectives on bioethics. The same year saw the publication of Sissela Bok's *Lying: Moral Choice in Public and Private Life* (1978). Arguably *Lying* marks the beginning of "practical ethics" as contrasted with "applied ethics" because of the close attention that Bok paid to the specifics of lying in particular circumstances and avoided abstract considerations.[4] Although *Lying* was not a work in bioethics, one topic to which she gave considerable attention was the lies told to patients by physicians.

Stephen Toulmin (1981) explicitly challenged to the Beauchamp-Childress method of subsuming cases under the abstract principles in his influential 1981 article "The Tyranny of Principles: Regaining the Ethics of Discretion." He argued from his experience of the actual conduct of moral reasoning—including his time as a member of the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research where authorities from varying moral, philosophical, and religious traditions frequently deliberated to consensus on policies for patient involvement in decision making. Judgment about what is morally acceptable occurs not "top down" from principles, he argued, but by analogical reasoning from case-to-case. This experience led Toulmin to collaborate with Albert Jonsen on *The Abuse of Casuistry: a History of Moral Reasoning* (1988), which deals with the method of case -to -case reasoning.

Can Norms Be Specific to a Profession?

Philosophers who took more abstract approaches to philosophizing were wary of attempts to identify particular responsibilities and moral hazards as characteristic of specific professions. Where those with abstract approaches discussed particular responsibilities at all, they tended to discuss them as an afterthought, and to reduce special responsibilities to a minimum by seeking to show that rules for professional behavior are derivable from more general or abstract values, such as fidelity or respect for persons. What is notable in these approaches is that in formulating their principles they did not first inform themselves about the actual problem situations about which professionals must deliberate. Thus they were in no position to recognize how those problem situations vary from profession to profession.

The practical ethics and applied ethics approaches disagree over whether principles can be formulated on the basis of reason alone, or whether, as Alasdair MacIntyre (1984) has argued, whatever meaningful principles and moral rules there are in ethics are not abstract but include understanding of their domain of application and derive from communities' experience of how to avoid moral pitfalls in the problem situations they do in fact encounter.

The sorts of problem situations encountered and hence the temptations and moral hazards encountered in those problem situations vary considerably from profession to profession. For example, engineers' relationships (with their clients, their employers, or members of the public—most of whom they never meet but for whose safety they have a responsibility) do not closely parallel the relationship of physicians to patients. Each type of relationship has its own moral challenges, which also affect the character of the profession, and each has its own types of moral hazards and temptations, to be guarded against with substantive rules of practice. No one denies that virtues are desirable in everyone. However, not all virtues are equally important for the fulfillment of all responsibilities. Thus impatience is tolerated in surgeons more readily than in kindergarten teachers, and indecisiveness is tolerated in kindergarten teachers more readily than in surgeons, because of the special demands and moral hazards of each profession.

Looking at the titles of early influential works that purported to be about moral problems, such as the 1976 collection of essays *Moral Problems in Medicine* (1976), one might expect that moral problems did receive attention. However, the essays in this collection do not deal with problem situations, much less with deliberation about how best to solve them. Rather, they are essays about types of acts, such as abortion and euthanasia, and they discuss in general terms, when, if ever, resort to those actions is justified. Such debates were conducted in terms that were largely irrelevant to those actually dealing with problems that might lead one to resort to those acts. After several years of such debates, some began writing about the *deliberation* of those in problem situations. In particular, feminist scholars with ties to the women's health movement sought to examine problem situations women faced and to expand their alternatives, rather than debate whether they had the right to resort to actions they would rather avoid resorting to at all (see Addelson 1991; Rothman 1986; Whitbeck 1983).

In an early defense of taking the ethics of the various professions as valid subject matter for scholars and attending to the problem situations they faced, Heinz Luegenbiehl observed that many moral problems arise in professional practice that are unfamiliar in ordinary life (1991). Later in this paper, I shall return to focus on the ethically significant problem situations that characterize practical ethics.

Those ethical "codes" and guidelines that members of a profession have created and revised over time provide a helpful guide to the problems actually encountered by professionals. Of course, codes and guidelines have many origins, but even those that reflect the experience of practitioners should not be assumed to give *exhaustive* specifications of what practitioners should or should not do. Instead, they provide guidance on handling *common* temptations and avoiding *common* pitfalls for those in the profession. Later I shall return to the question of how the norms in codes of various professions differ.

Practical Ethics and Applied Ethics

As I have been using the term, the "applied ethics" approach to professional ethics is the application of rationalist foundationalist ethical theory or abstract ethical principles (MacIntyre 1984). These principles are abstract in that they are supposedly apprehended in abstraction from context. An example would be the principles of justice that, as John Rawls suggested, would be chosen from "behind a veil of ignorance," that is, rational beings ignorant of their own position in society (and so without the benefit of any actual moral experience) would choose them.

In contrast, practical ethics begins with ethically significant practical problems and the enduring (rather than "timeless") moral rules and norms that have been developed to give guidance to those addressing those problem situations. In the case of professional ethics these would be ethically significant problems of the sort that commonly arise in professional practice (not rare, extreme, or science fiction cases) and the norms of responsibility appropriate for those with the special knowledge and opportunities for action possessed by members of the profession in question. Other areas of practical ethics deal with problems encountered by other groups, such as family members or citizens. Some areas of practical ethics are organized by topic, such as biomedical ethics. These include problems and responsibilities of professionals and nonprofessionals (such as patients). Therefore, professional ethics overlaps with other categories within practical ethics. In particular, policy questions about health care or technological development *partially* overlap with ethics of the relevant professions.[5]

Some who pursue practical ethics are philosophers aware of the philosophical literature arguing that deliberation is the central form of moral reasoning. However, many are not philosophers but are simply interested in finding good (or better) ways of addressing problems or developing good policies for preventing difficulties, harms, injustices, and the like.

In recent decades, many who initially adopted the applied ethics approach have modified their views to take account of the insights that have come from practical ethics. However, four tendencies of the applied ethics approach persist into the present day. The first of these is the emphasis on application of foundationalist ethical theory (that is, one or another view of what reason alone supposedly tells us is the crux of ethics). The second is the emphasis on analysis to the neglect of synthetic reasoning. Third is the tendency to treat moral problems as if they came with their possible solutions attached, that is, as if they are multiple-choice problems. The fourth is the tendency of proponents of applied ethics to ignore their own historical and cultural position and to argue as though their principles were timeless truths.

The invocation of rationalist foundationalist theory with assumptions born of the European Enlightenment is a particular problem for development of a more international and cross-cultural discussion of professional ethics. Although wide acceptance has been accorded to the notion of human rights as defining a minimum in the treatment of individuals, many cultures view the group, rather than the individual, to be the proper focus of attention in moral matters.

The contextual emphasis in practical ethics makes it better able to recognize and adequately account for differences across cultures and societies, even as agreements such as the "Washington Accord" on the Recognition of Equivalency of Accredited Engineering Education Programs Leading to the Engineering Degree—see, http://www.washingtonaccord.org/wash_accord_agreement.html —seek to develop some uniform international standards for professions.

Philosophical Ethical Theory, Foundationalist and Other

Rationalist foundationalist theories hold that reason by itself gives us a specification of what ethics "all comes down to." For example, "behaving ethically consists in acting to achieve the greatest good for the greatest number," or "behaving ethically consists in acting so that one treats every one as an end and not as a means only," or "acting from the motive to do one's duty," "respecting the rights inherent in persons", or "keeping one's agreements."

Aristotle and pre-Enlightenment philosophers as well as continental philosophers from Nietzsche to Jonas all understood philosophical ethics in a very different way from the foundationalists. So, although Aristotle holds up the question of the "good for man" as the central question of ethics, his theory does not specify a test of "right action," let alone maintain that some test is dictated by reason alone, apart from social experience.

New theoretical approaches containing thoroughgoing critiques of all abstract approaches to ethics (and philosophizing) have arisen in Anglo-American philosophy since 1980. For example, Annette Baier approvingly quotes Bernard Williams as saying:

> [T]he ideal of transparency and the demand that our ethical practice should be able to stand up to reflection do not demand total explicitness, or a reflection that aims to lay everything bare at once...I must deliberate from what I am. Truthfulness requires trust in that as well, and not the obsessional and doomed drive to eliminate it (Williams 1985, p. 200).

Baier goes on to say:

> Though I welcome Williams's emphasis on the importance and fragility of confidence, and his reminder of the close link between the trusty and the true, I would amend his statement to "*we* must deliberate from where *we* are"; for, as he himself emphasizes, confidence and trust are social achievements (Baier 1986, 544-545).

Philosophers like Baier and Williams argued that the abstract mode of philosophizing poses the danger of making ethics irrelevant to actual moral life, rather than leading to moral corruption, as had Anscombe. Such arguments against the appropriateness of abstract and detached philosophizing in ethics drew strength from Thomas Nagel's argument in his book, *The View from Nowhere* (1986), against detached philosophizing in general.

The most naïve use of rationalist foundationalist theory in applied ethics has been to treat such theories as though they were specifications of what one ought to attend to in responding to particular moral problems. So for example, consequentialism (in either its utilitarian or intuitionist forms) is treated as requiring that one consider only consequences in responding to a problem situation. This is a mistake, of course, as the example of Richard Brandt's rule utilitarianism clearly illustrates. Brandt did believe that ethics comes down to achieving the best consequences, but that following certain rules would achieve the best long run consequences and it was the rules rather than individual acts that should be subjected to the utilitarian test. Clearly some utilitarians would council considering applicable moral rules and others would the consequences of particular responses to the problem. What makes them utilitarians, rather than, say, contractarians or deontologists, is their embrace of the abstract principle that being ethical consists in producing the greatest utility for the greatest number. Of course, Brandt does not give a catalog of moral rules that pass the utilitarian test any more than act utilitarians tell us how to learn all the consequences of potential responses or how to deal with outcomes that are not expressed as arithmetic quantities. They are not giving directions on how to manage *concrete* moral problems.

Some who take an applied ethics approach are much more sophisticated and would never make the mistake of treating rationalist foundationalist theories as though they were specifications of what one ought to attend to in responding to particular moral problems. Even they emphasize analytic reasoning to the neglect of synthetic reasoning and tend to treat moral problems as multiple-choice problems, however.[6]

Applied Ethics Approach to Deliberation

To illustrate the difference between applied ethics and practical ethics in the adequacy of their treatment of deliberation, consider the method of deliberation proposed by one of the most careful and sophisticated proponents of applied ethics. Jim Childress specifies the following steps for finding an "ethically justifiable course of action" and describes his as a method as one for "ethical ***analysis*** of cases." [7] The steps in the method are:

1. Describe **all** the facts in the case.
2. Describe the relevant principles and values of the …interested parties.
3. Determine the main clash of values and principles.
4. **Determine** possible courses of action that could protect as many of the principles or values in the case as possible.
5. **Choose and defend** one course of action on the basis of the relevant principles and values.
6. In the defense show that the conditions for overriding *prima facie* principles and values are met. [He then specifies five conditions, such as "the agent must seek to minimize the negative effects of the infringement."]

Childress is right that his method is one of analysis, but synthesis is also required to devise a course of action. Childress's scheme draws attention to some important considerations, however. For example, his emphasis in step 4 on protecting as many of the principles or values in the case as possible is a major improvement over earlier applied ethics methods that merely sought to satisfy the top-ranked principle at the expense of others. In what it omits, however, it misrepresents the process of devising a good response to a moral problem. Note first, the formulation of the problem is a major step that is simply assumed in Childress's method, and the problem-solver is assumed to be in the omniscient position of possessing all the facts and "the relevant principles and values of the … interested parties."

Although Childress elucidates how to defend or justify one's choice, the "determination" of the possible responses remains a mystery. To determine a course of action (rather than to devise a course of action) suggests that one is to identify possibilities that are established before the agent decides what to do. Indeed, if the possibilities were not established for the agent, it is hard to see how this step could be one of analysis. Where the courses of action come from or how the agent establishes what they are is not explained.

Childress offers this method not for trivial moral problems, cases in which one might say that reasonable responses are obvious, but for cases that are thought interesting or difficult, since step 3 explicitly assumes that the agent confronts a conflict of values or principles.

In what it assumes Childress's method has much in common with the method of decision analysis in which the first step is to "define," or to "identify and bound," the decision problem, that is, to identify possible alternative actions, types of relevant information that will be available, possible consequences, and other considerations such as cost and societal impact. In carrying out the first step in using decision analysis, those setting up the problem ***specify*** both what considerations are relevant and what alternatives are possible, that is, one sets up a multiple choice problem with value estimates of the consequences of those actions and their likelihood.

Problem Situations in Practical Ethics

In practical ethics (including professional ethics), the focus is on problem situations and statements of ethical norms derived from the experience of practitioners and others involved in and affected by the practice ("stakeholders"). The problem situations are often called "problems" for short—in the sense of situations to be addressed, not necessarily difficulties—rather than "cases."

Problem situations are more than "war stories"; problems call for response. The norms articulated in ethical codes and guidelines are aids to taking action in such problem situations. Of course, calling some rules or guidelines "ethical" does not make them ethical. Codes of ethics may enjoin practitioners to behave in ways that have no ethical significance, or may even be unethical. Furthermore, the norms articulated in many written codes and guidelines can be elicited from experienced engineers. What is important is drawing on the experience of the relevant communities and professions, whether or not such cumulative reflection is written down. To understand the ethical import of the actions such guidelines enjoin, one must understand the problem situations that they are meant to address. Therefore, the formulation and interpretation of problem situations and of ethical guidelines and other statements of norms are mutually informative and correcting. Important facets of a problem may come to light when it is viewed in relationship to ethical guidelines, and gaps and practical problems may show up deficiencies and omissions in ethical guidelines. In attending to particulars, practical ethics does not fall prey to being anecdotal and unsystematic. Practical ethics considers, articulates, and critically reflects on the ethical systematizations that communities have developed to address specific sorts of problems that arise in specific societal contexts, as well as those developed by philosophers.

Professions and their Norms of Practice

As professions have developed, the ethical aspects of the specialized problems of professional practice have garnered more attention both from within and without those professions.

I accept the characterization of professions as the occupations that both require mastery of a specialized body of (theoretical and practical) knowledge and seek to promote or protect one or another significant aspect of others' well-being. Professionals are expected to integrate complex knowledge to achieve good outcomes or prevent bad outcomes for others. As a result, others without that knowledge cannot judge the competence or conscientiousness of their practice except in the grossest terms. For example, whereas anyone can judge that a surgeon is at fault for sewing up the patient with surgical instruments inside, only another surgeon, or perhaps only another practitioner of the same surgical specialty, can judge the quality of a surgery she has just witnessed. Although society needs trustworthy behavior on the part of all whose work significantly affects human well-being, society must trust members of a profession to ensure the quality of the practice of their profession to a larger extent than it must trust members of other occupations.

Because professions draw on a complex body of knowledge to further the well-being of others, the moral norms for their practice include responsibilities—most centrally, the responsibility to promote or protect that well-being—as well as moral rules and obligations. Whereas moral obligations and most rules specify the *acts* that are required or forbidden, fulfilling a responsibility characteristically requires achievement of an end. Carrying out a responsibility requires the making of complex judgments about which *acts* will best achieve the desired *ends*.

The ends or results that the professionals in engineering, research, medicine, or law work to achieve include, respectively, worker or public safety, sound research results, a good health outcome for one's patient, and a good legal outcome for one's client. The professional must figure out in each case what acts will achieve the desired ends, and this requires complex problem-solving skills.

In contrast to societies that are merely scientific, technical, scholarly, learned, or disciplinary societies that focus exclusively on technical or scholarly advances in a discipline, professional societies may also have a disciplinary focus, but they address the professional behavior of their members and issue explicit statements of ethical norms for professional conduct. Accordingly, philosophy is a discipline, not a profession, while teaching is a profession. The National Society of Professional Engineers (NSPE) and the Order of Quebec Engineers (OIQ) are professional societies, but the American Philosophical Association is not. The International Institute for Electrical and Electronic Engineers (IEEE), the Information Processing Society of Japan, and the System Administrators' Guild of Australia (SAGE-AU) each have a dual focus, on both professional issues and disciplinary advances.[8]

Engineering societies in continental Europe, such as the Flemish KVIV, the Dutch KIVI, and most recently the German VDI, have developed a professional as well as technical focus only relatively recently. Although this means that their codes of ethics have not yet been time-tested against the moral experience of practitioners, the practical ethics approach that I discussed earlier and am about to demonstrate is possible to use.

If we examine codes of ethics for professions, we find that some rules are common, at least within a profession. An example is the prohibition of bribery, or at least bribery to obtain work, that is generally found in engineering codes of ethics.[9]

- The code of ethics of the IEEE states: "We, the members of the IEEE, … do hereby commit ourselves to the highest ethical and professional conduct and agree …. [10 items, including] to reject bribery in all its forms."

- The Institution of Engineers, Australia (IEA) gives in their Examples of Rules of Practice 2: "[Members] shall neither pay nor offer directly or indirectly inducements to secure work."

- The Code of Ethics of the OIQ states as provision 3.02.09: "An engineer shall not pay or undertake to pay, directly or indirectly, any benefit, rebate or commission in order to obtain a contract or upon the carrying out of engineering work."

The American Medical Association (AMA) has a provision against fee- splitting in its code of ethics. "Fee-splitting" in the context of medicine is paying a kickback to another physician for having that physician refer the fee-paying patient. The prohibition against fee-splitting is similar to the stricture against paying a bribe to obtain work in that both bribing and fee-splitting represent ways in which inferior practice threatens to thrive over proficient practice. The difference between the two prohibitions reflects differences in the ways in which members of each profession obtain work.

Moral Rules That Vary with Profession

How are we to understand the similarities and differences in the moral norms of various professions and professional organizations? As I have pointed out elsewhere (Whitbeck 1998, chapter 2), codes of professional organizations illustrate how ethical standards vary with the moral problems encountered by a profession. Some rules of practice in one profession have counterparts in other professions. Others do not. For example, rules about maintaining client confidentiality appear in law and health care as well as engineering, but in the codes for medicine there is no rule precisely corresponding to the rule in engineering codes against taking work outside one's competence. Perhaps this is because medical education regularly teaches some procedures by having trainees perform them on patients, so that one is doing procedures *before* one is proficient in doing them, in order to develop that proficiency.

Some professions are more concerned than others about the potential for compromise or appearance of compromise of professional judgment posed by receiving a commission for one's work. So the U.S.'s National Society of Professional Engineers (NSPE) takes an especially dim view of engineers (but not of those outside engineering) working on a commission basis.[10] The absence of such concerns in medical codes of ethics may only reflect that relative rarity with which physicians are asked to work on commission, or where doing so would threaten to compromise professional judgment.

In addition to differences in the frequency with which some problems arise are differences in the vulnerabilities of those with whom the professional encounters in professional practice. An illustration is the prohibition within the AMA code of ethics of what is sometimes called "patient abandonment":

> Once having undertaken a case, the physician should not neglect the patient, nor withdraw from the case without giving notice to the patient, the relatives, or responsible friends sufficiently long in advance of withdrawal to permit another medical attendant to be secured.

Engineering codes do not have such a rule. The only one that I have found that even mentions withdrawal from service to a client is the 1983 code of the OIQ. Their provisions 3.03.04 and 3.03.05 state respectively:

- "An engineer may not cease to act for the account of a client unless he has just and reasonable grounds for so doing. The following shall, in particular, constitute just and reasonable grounds (a) the fact that the engineer is placed in a situation of conflict of interest or in a circumstance whereby his professional independence could be called in question; (b) inducement by the client to illegal, unfair or fraudulent acts; (c) the fact that the client ignores the engineer's advice," and

- "Before ceasing to exercise his functions for the account of the client, the engineer must give advance notice of withdrawal within a reasonable time."

Even here there is no suggestion that an engineer must be sure that another engineer will take over the work. The vulnerability of patients is much greater vis-à-vis their physicians than is the vulnerability of engineer's clients, and this makes a difference to the norms of their practice.

On the other hand, current codes of ethics for several engineering societies, including the American Society of Mechanical Engineers (ASME) and the American Society of Civil Engineers (ASCE) state, "Engineers shall perform services only in areas of their competence." No such stricture is placed on physicians. This may be due to the fact that at least for the present medical training always involves having physicians learn on patients.

Of course, we may ask whether new provisions should be added or existing ones ought to be abandoned. When the problem of the physical abuse of children came to light in the U.S., physicians were assigned a new duty to report such cases and educated to identify patterns of injury that were likely to have been intentionally inflicted. Provisions within U.S. engineering codes about not criticizing the work of other engineers were recognized to interfere with the need and responsibility of the profession to police itself and were eliminated or changed to prohibitions against *unfairly* criticizing the work of other engineers.

Varying Legal and Societal Conditions

Although basic similarities in conditions of engineering practice are found in technologically developed democracies, different legal traditions influence norms of professional practice.

For instance, the U.S. recognizes a right of freedom of speech and interprets this right more broadly than do other technologically developed democracies. As a result, the U.S. was slow to sign on to the U.N. Declaration on Human Rights, because some of its provisions, particularly the provision against hate speech, threatened to interfere with the constitutionally protected right of free speech. In the end, the U.S. signed on with the provision that it could not agree to anything that conflicted with the U.S. constitutional right to free speech.

By contrast, defamation is considerably easier to prove in Australia than in the U.S. In particular, in Australia truth is not a sufficient defense against it. (Perhaps this is a legacy of having once been a penal colony and the attendant widespread desire to let people make a new start.) The IEA code of ethics stipulates that its members shall “neither maliciously nor carelessly do anything to injure, directly or indirectly, the reputation, prospects or business of others.”

This example illustrates how societal and cultural factors can introduce differences in available options and hence in the practical deliberations of engineers (and other professions in which safeguarding the public is a responsibility), even in technologically developed democracies.

Conclusion

The “applied ethics” approach proceeds from the formulation of abstract principles held to derive from reason alone, and applies these abstract principles to instances. This approach focuses on analytic reasoning exclusively. In contrast, practical ethics begins with ethically significant problem situations and recognizes the need for synthetic as well as analytic reasoning to devise responses that satisfy many ethically significant criteria simultaneously. It recognizes that the moral rules it uses come from experience and thus are influenced by the particular problem situations that arise in the community whose experience is distilled in those rules. Although it frequently benefits from insights from ethical theory (including from the insights of foundationalists), practical ethics does not attempt to formulate ethical norms in abstraction but draws on experience as well as philosophical insight to illuminate the ethical aspects of particular problem situations.

Philosophers who take a practical ethics approach expect to draw on the experience of relevant communities, in the case of professional ethics that would be members of the profession in question. Therefore, they expect to work collaboratively with members of the profession they study and with other humanists and social scientists and benefit from their insights and criticisms.

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Notes

[1] I would emphasize that I heard this view voiced even by senior figures who *participated* in the early conversations in professional ethics and even several who went on to contribute to a much more nuanced view of philosophical ethics, including professional ethics.

[2] Notice that it is advance calculation rather than consideration in deliberation that Anscombe finds so heinous, as she says in a footnote, "If he thinks it in a concrete situation, he is of course just a normally tempted human being. Deliberation is quite different in character from testing theoretically based moral rules with extreme dilemmas." " Modern Moral Philosophy" is of major philosophical importance for many other points that it makes, as well, including the need for philosophical psychology and what came to be called "action theory."

[3] I have given an overview of the range of these criticisms at http://onlineethics.org/bib/appendix.html

[4] Note especially her discussion of the limitations of (foundationalist) ethical theory in illuminating practical ethics in the section titled "Systems" in Chapter IV, "Weighting the Consequences."

[5] Some policy questions may be regarded as questions of engineering ethics, that is that some questions, which are called "macro" questions, are questions of engineering ethics even if society as a whole, rather than engineers alone, must answer them. The term was introduced by Ladd (1980. See the discussion of it by Herkert (2001

[6] I argue for an alternative view of moral problems in greater detail in Whitbeck (1996).

7 *Guidelines for the Ethical Analysis of Cases* handed out by James Childress at the AAAS Minority Scholars Workshop on Values and Ethical Issues in Science & Technology (July/August 1991). Quoted by permission. Childress says the method was adapted with major modifications from Loyola University Stritch School of Medicine, Medical Humanities. I have added bolding to terms of particular significance for my argument. I have discussed this example elsewhere in Whitbeck (1997b).

8 Codes of ethics have a long history in U.S. engineering societies. They were proposed from the 1880s, and the first code of ethics finally adopted was the AIEE's code in 1912 (Layton 1971, p. 84).

9 Some of these examples and illustrations appear in Whitbeck (1998).

10 See for example the judgment of the NSPE's Board of Ethical Review on their case 78-7 at http://onlineethics.org/cases/nspe/nspe78-7.html.

Towards a Social Ethics of Technology: A Research Prospect

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Introduction

Most approaches to ethics focus on individual behavior. In this paper, a different approach is advocated, that of social ethics, which is offered as a complement to individual ethics. To some extent, this is an exercise in renaming some current activities, but it is also intended to clarify what is a distinct and valuable ethical approach that can be developed much further than it is at present. What is described here as social ethics is certainly practiced, but it is not usually treated as a subject for philosophical inquiry.

Social ethics is taken here to be the ethical study of the options available to us in the social arrangements for decision-making (Devon 1999; see also a follow-on article to the present one, Devon and Van de Poel 2004). Such arrangements involve those for two or more people to perform social functions such as those pertaining to security, transportation, communication, reproduction and child rearing, education, and so forth. In technology, social ethics can mean studying anything from legislation to project management. Different arrangements have different ethical tradeoffs; hence the importance of the subject.

An illustration of social ethics is provided by the case of abortion (a technology). The opponents of abortion take a principled position and argue that abortion is taking a life and therefore that it is wrong. The opponents of abortion believe all people should be opposed and have little interest in variations in decision making practices. The pro-choice proponents do not stress taking a position on whether abortion is good or bad but rather on taking a position on who should decide. They propose that the pregnant woman rather than, say, male dominated legislatures and churches should have the right to decide whether or not an abortion is the right choice for them. The pro-choice position would legalize abortion, of course, hence the debate. The pro-choice position, then, is based on social ethics. Very clearly, different arrangements in the social arrangements for making a decision about technology (abortion in this case) can have very different ethical implications and hence should be a subject for conscious reflection and empirical inquiry in ethics.

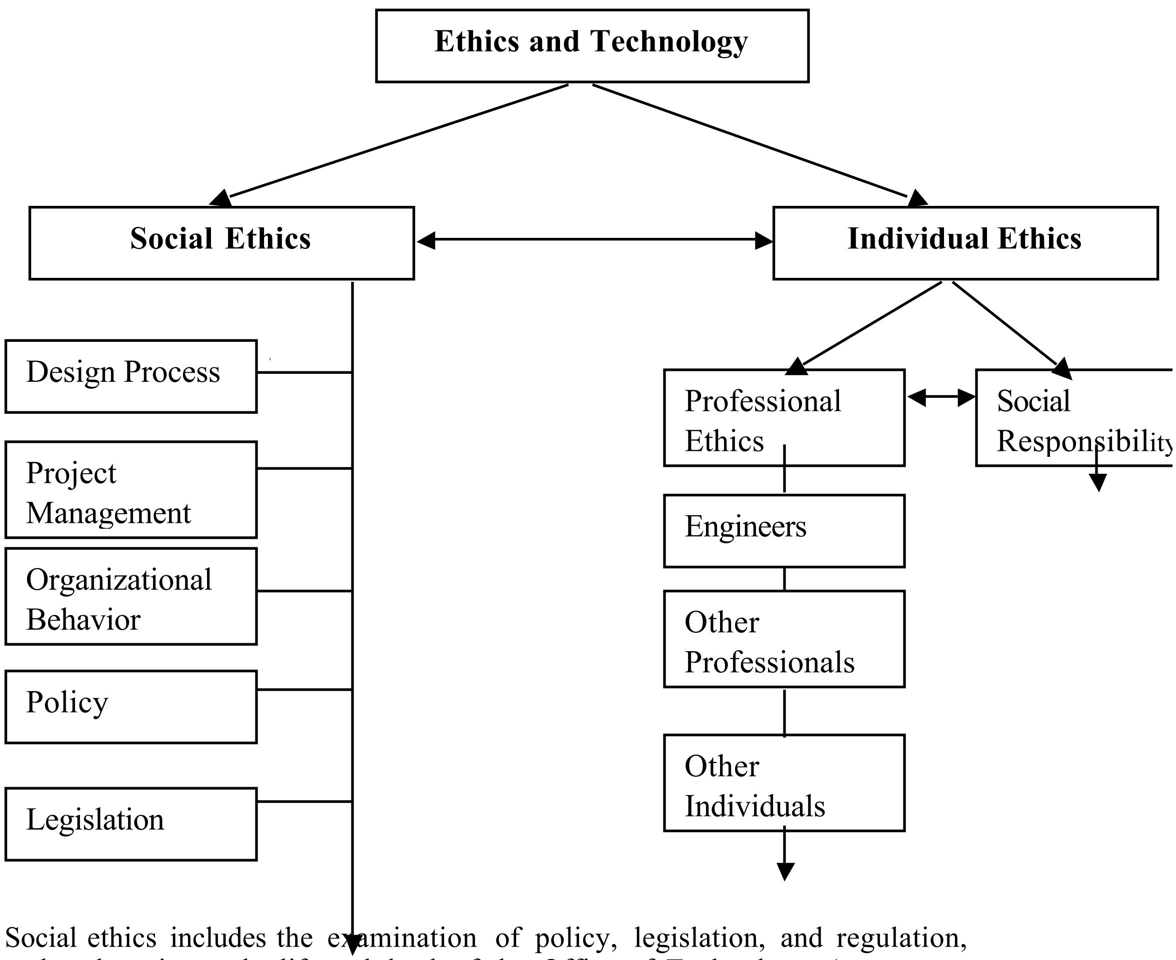
There is no shortage of illustrations of the role of social ethics in technology. Consider the question of informed consent in the case of the Challenger. The launch decision was made in the light of a new and considerable risk, of which the crew was kept ignorant (Boisjoly 1998; and see Vaughan 1996). This apparently occurred again in the case of the Columbia (Ride 2003). Informed consent, absent here, is a well-known idea and represents a social arrangement for making a decision. The skywalk of the Hyatt Regency failed because of a design change that was both bad and unchecked (Petroski 1985; Schinzinger & Martin 2000, p. 4). A bad decision is one thing, an unchecked decision means that the social arrangements for decision-making were inadequate. The original design was also bad (very hard to build) and this was largely because the construction engineers were not consulted at the outset. Similarly, this was a bad social arrangement for making decisions, and it may be compared to the concurrent engineering reforms in manufacturing that use product design and development teams to ensure input from both design and manufacturing engineers among others. An unchecked, faulty design decision by a construction company was also the cause of the lift slab failure during the construction of Ambience Plaza (Scribner & Culver 1988; Poston, Feldman, & Suarez 1991). The Bhopal tragedy was the result of a failure in a chemical plant where many safety procedures were disregarded and almost every safety technology was out of commission (Schinzinger & Martin 2000, pp. 188-191). The global oversight of Union Carbide at the time rested on the word of one regional manager, which was not a safe management practice either (McWhirter 1988).

It is hard to find a textbook on engineering ethics that takes project management as a worthy focus for analysis. Schinzinger and Martin (2000, p. 3-5) do have a good engineering task breakdown but it is not focused on management. And project management is not usually prominent in engineering curricula. Where it is present, ethics is usually not included (e.g., Ulrich & Eppinger 2004). Yet, as the examples above suggest, it is very easy to see the importance of project management in most of the famous case studies of engineering ethics.

Studying only individual behavior in ethics raises a one-shoe problem. It is valuable to lay out the issues and case studies and to explore the ethical roles of the participants. However, what we also need to study are the ethics involved in how people collectively make decisions about technology. A collective decision has to be made with participants who have different roles, knowledge, power, personalities, and, of course, values and ethical perspectives. This is the other shoe. How do they resolve their differences and, or, combine their resources and wisdom? And insofar as engineering ethics only focuses on engineers and not on the many other participants in decision-making in technology, it exacerbates the problem (Devon 1991).

Studying ethics and technology means looking at both individual and collective behavior in the production, use, and disposal of technology. This broad scope may be contrasted with the best-developed sub-topic of professional ethics applied to engineering, which has concentrated on roles and responsibilities of working engineers (see Figure 1).

Figure 1



Social ethics includes the examination of policy, legislation, and regulation, and such topics as the life and death of the Office of Technology Assessment in the United States (Kunkle 1995). It also provides a useful method of inquiry into ethical issues in the design process (Devon & Van de Poel 2004) and in project management. These are very practical areas in which researchers may well attract corporate and public funding. As noted above, many of the case studies that are currently popular in texts and websites on engineering ethics may best be reduced to issues of poor project management: that is, reduced to social rather than individual ethics. See, for example, http://www.onlineethics.org/ and http://ethics.tamu.edu/. The social ethics of technology is not simply a matter of extending the scope of ethics to collective decision-making. The method needs exploring and developing. And we need empirical studies of the ethical effects that different social arrangements have for decision-making. Research, a lot of research, is the next step.

Fortunately, social ethics is practiced ubiquitously; even professional codes have plenty of statements that concern the social ethics of technology. And the codes themselves represent a social arrangement that has been commented upon extensively. What is lacking, and what is proposed here, is a clear scholarly methodology for developing the field.

Politics or Ethics

As with Aristotle's view of both ethics and politics, ethics is seen here as the practical science of finding the right goal and the right action to achieve that goal. Engineering ethics, as it has been traditionally viewed, is a subset of this larger domain of the ethics of technology, since many others join engineers in the way technology is created and used. Whereas engineering ethics has tended to answer the question what makes a good engineer good, a social ethics of technology asks what makes a good technology good (Devon 1999).

Traditionally, ethics has primarily been the study of appropriate standards of individual human conduct (*Nichomean Ethics* 1990). Anything about appropriate social arrangements has been referred to as politics, notwithstanding Aristotle's view of ethics a subset of politics, which he viewed as the supreme science of correct action and obviously a collective process (Aristotle *Politics*; Apostle & Gerson 1986).

Engineering ethics has been affected by this dichotomy between what is ethical and what is political. An exchange in the *IEEE Spectrum* revealed this distinction clearly (*IEEE Spectrum* December 1996; February 1997; March 1997). After well known experts on engineering ethics had engaged in a roundtable on the subject, several engineers wrote letters that included the argument that two of the ethicists had "confused a political stance with ethics" (*IEEE Spectrum* February 1997). The topic was the work of engineers in various technologies such as chemical and other warfare technology, and even working on the Cook County Jail. The ethicists in question did, in fact, indicate personal opposition to such technologies and the letter writers were making ethical defenses of working in such fields of engineering.

The letter writers in this case clearly felt that engineering ethics, as presented, was excluding their values and, worse, condemning them. The same experience occurred in the newsletters and meetings of a small, short-lived group called "American Engineers for Social Responsibility," in which I participated. A single set of values was presented under a general rubric for values, implicitly excluding (pejoratively) those who held other values, some of whom told us as much. On the other hand, many engineers who feel there are major ethical problems with the deployment of their skills can gain little solace from codes of engineering ethics, and not much more from the discourse of their professional societies.

We presently have no satisfactory way of handling this type of discourse/conflict within engineering ethics, beyond making optimistic injunctions such as calling for employers to accommodate any disjuncture between the ethical profiles of employees and the work assigned to them by the companies that employ them (Schinzinger & Martin 1989, p 317; Unger 1997, pp. 6-7) This frustration has led to protest emerging as a theme in engineering ethics, and this, in turn, gets rejected by many engineers as being politics rather than the ethics.

There is a way of dealing with the problem. Taking a social ethics approach means recognizing not only that the ends and means of technology are appropriate subjects for the ethics of technology, but also that differences in value systems that emerge in almost all decision-making about technology are to be expected. The means of handling differences, such as conflict resolution processes, models of technology management, and aspects of the larger political system, must be studied. This is not to suggest that engaging in political behavior on behalf of this cause or that is what ethics is all about. That remains a decision to be made at the personal level. Rather, the ethics of technology is to be viewed as a practical science. This means engaging in the study of, and the improvement of, the ways in which we collectively practice decision making in technology. Such an endeavor can enrich and guide the conduct of individuals, but it is very different than focusing on the behavior of individuals in a largely predetermined world in which their options are often severely constrained.

The Scope and Method of Social Ethics

The social ethics of technology is not just a consequentialist approach. The desired outcome is taken to be good technology, but the process of getting there (right social action) is also very important in social ethics. Rather than look at right action in principled terms, focused on the individual, an action may equally be ethically evaluated on the basis of the social process leading up to it.. Deontological social ethics means that if the process is a good one, the results will take care of themselves. Practitioners may view the right process as the best they can do and tolerate a wide range of outcomes as a result. So, for example, if we establish good democratic information flows and decision-making in the design process, we will have answered the question of what is a "good" technology with one solution: one produced by a good process. Similarly, we may still take a social consequentialist approach and examine the outcomes, just as we do at the individual level, and change the social arrangements to achieve the types of outcomes that seem ethically desirable. Virtue ethics might also be applied with examples of establishing decision making groups of virtuous people. It all sounds familiar, but it is not studied as a science of ethics.

Technology is socially constructed. Technological designs express what we want and they shape who we are. People in all walks of life are involved in demanding, making, marketing, using, maintaining, regulating, and disposing of technology. Design is the focal point of technology. It is where societal needs meet technological resources in a problem-solving context. As we design technology, so we design our lives, realize our needs, create opportunities, and establish constraints, often severe, for future generations. It is the design process that creates the major transformations of society and the environment that technology embodies. Early stages of the design process determine most of the final product cost and this may be emblematic of all other costs and benefits associated with technology (National Research Council 1991). The similarity between applied ethics and design has been noted (Whitbeck 1996). Design may be the best place to study ethics in technology. Design affects us all. However, not all of us are involved in design, and this asymmetry has great import for the social ethics of technology.

Most decisions about technology are collective, to which individuals only contribute, whether in a product design and development team, or in a legislature. The nature of such collectivities varies enormously. There are many different varieties of organizations in industry, and many different governmental bodies. Consider the area of risk management, for example. In addition to personal judgment, there are many different institutions involved such as legislatures, regulatory agencies, tort and common law, insurance, worker's compensation, government industry agreements, and voluntary standard-setting organizations (Merkofer 1987). One can examine individuals purchasing a consumer product, and the subsequent use and disposal decisions that follow. Family members and friends play a significant role in all these stages, not to mention advertising, insurance, laws, and community codes. This is not to deny that individuals are very important in innovation, buying commodities or making administrative decisions, but the autonomy implied by a sole focus on individual ethics may exaggerate the ethical space that is usually available and distract attention from more powerful social realities.

Accepting that we have complex social arrangements for handling technology, it is also true that these arrangements are mutable. For example, in the last three decades, international competition has revealed different approaches to the social organization of industry. The long dominant top-down scientific management approach is steadily being replaced by flatter organizations with more participatory management (Smith 1995). Product design and development teams are replacing the old sequential approach to engineering. These changes occurred because they made companies more competitive, but they also have profound ethical implications for the people who work for the companies. A case can be made that the ethical situation improves in some ways for the employees with the change to participatory management. Similarly, greater sensitivity to customer needs also has an ethical benefit even though tradeoffs are not hard to find (Whiteley 1994). In fact, not viewing the social relations of production as a variable made U.S. industry very slow to see what their competition was doing.

To summarize, decisions are usually made collectively and in social arrangements that represent one of many possibilities. Further, changes in these social arrangements must have an impact not just on the technology but on the ethics involved in the technology, both as product and in the processes that create that product. Surely, then, we can consider the study of these social arrangements as appropriate subject matter for the ethics of technology. Dewey argued in much the same way for a scientific and experimental approach for ethics in general. "What is needed is intelligent examination of the consequences that are actually effected by inherited institutions and customs, in order that there may be intelligent consideration of the ways in which they are to be intentionally modified on behalf of generation of different consequences" (Dewey 1996, p. 305).

Project Management and Social Ethics

Since the way technology is created and managed in society is vast and complex, how can we hope to study it systematically? One answer is that there is a lot of work to do close at hand, such as the design and operation of product design and development teams and other forms of project management. For example, as noted in the Introduction, many failures that are used as case studies in engineering ethics seem to have project management pathologies at the heart of them. Apparent examples are: not checking a design and not enforcing worker safety rules in the Ambience Plaza lift slab collapse (op cit.), assigning the person with the wrong competency and, again, not checking a design in the chemical plant explosion at Flixborough (Taylor 1975), failing to exercise design control over changes during construction of the Citicorps Building in New York (Morgenstern 1995), and the Hyatt Regency in Kansas City (op cit), not providing proper training in handling toxic chemicals in the case of the "Aberdeen Three" (http://ethics.tamu.edu/ethics/aberdeen/aberdee1.htm), and not maintaining proper management, and oversight of a plant at Bhopal (op cit.). Although there are dramatic ethical issues involved in these cases, none of the disasters seems to reduce well to a problem of individual ethics. They are prime case studies for teaching project management and social ethics, however. For further analysis of such case studies, see Devon and Van de Poel (2004).

An excellent exception to most case studies is the study of the DC-10 failures and crashes (Fielder & Birsch 1992). This set of studies explicitly engages in social ethics by examining the role of corporate and regulatory behavior, and revealing, for example, that engineers' concerns at subcontractors such as expressed in the Applegate memo had no legal means of reaching the FAA which was responsible for the regulatory oversight. This was an arrangement that could have been different.

The Role of Cognizance

Up to this point we have made a case for a social ethics of technology. Now, two general values are suggested that are important in realizing a social ethics of technology. Cognizance is important. We have an obligation to understand as fully as possible the implications of a technology. While such understanding seems to be increasingly characterized by uncertainty, we are still obliged to do the best we can. There is simply no point making ethical judgments in a state of reparable ignorance.

Some texts have appeared that provide new resources in areas where information has been lacking. For example, it is now possible to have some idea of the global social and environmental changes that create the life cycles of consumer products (Ryan, et al. 2000; Graedel & Allenby 2003). This is at least a surrogate for inclusion (see below). But it is still easier for engineers to understand a lot about how a technology works as a technology, while having a limited understanding of its possible uses and its social and environmental impacts in extraction, production, use, and disposal. Experts are usually paid for their technical expertise and not for their contextual understanding – nor do their bosses usually ask for it. It is irritating to wrestle with, and to solve, the technical issues of a problem, only to be confronted with social issues such as marketability, regulatory constraints, or ethical concerns (Devon 1989). It is a recipe for producing defensive behavior. So, it is not enough to call for cognizance, we need a methodology. And, while cognizance can be achieved by social responsibility approaches at the individual level, the methodology suggested will show how social ethics can powerfully supplement the conscience and awareness of individuals.

The Role of Inclusion

This brings us to our second general value: we need to make sure the right people are included in the decision making. Deciding who the "right" people are should be a major focus in the social ethics of technology. Who they might be is a point of concern in any industry where the clients, customers, design and manufacturing staff, sales engineers, lawyers, senior management, and various service units such as personnel are all relevant to a project. And there will be other stakeholders such as environmental agencies, and the community near a production plant, a landfill, a building, or a parking lot. The classic article by Coates on technology assessment is instructive in this regard (Coates 1971). Inclusion might be viewed as the difficult task of adding stakeholder values to shareholder values, but that would be a misleading representation.

Neglecting different stakeholders will have different outcomes at different points in history. Neglect your customer and you risk losing money. Fail to design for the environment and you may pay heavily later. Neglect safety standards and you risk losses in liability as well as sales. Neglect underrepresented minorities and the poor by placing toxic waste sites in their communities and you may get away with it for a long time, but probably not for ever. In general, neglecting stakeholders, even when you are free to do so, is a calculated risk and rarely ethical. The consequences of failure can be severe. Nuclear energy technology ground to a halt with huge amounts of capital at stake, in part, because the stakeholder issue was so poorly handled. Once the public trust had gone, even reasonable arguments were discounted.

Involving diverse stakeholders helps with the problem of cognizance since this diverse representation will bring disparate points of view and new information to bear on the design process. There is also evidence that inclusiveness with respect to diversity generates more creativity in the design process (Leifer 1997) and facilitates the conduct of international business (Lane, DiStefano, & Maznevski 1997). Creating more and different options allows better choices to be made. While the final choice made may not be the most ethical one, a wide range of choices is likely to provide an alternative that is fairly sound technically, economically, *and* ethically. To some extent then, the broader the range of design options that are generated, the more ethical the process is. Thus, increasing representation in the design process by stakeholders is ethical in itself and it may be in its effect on the final product or process, also, by expanding cognizance and generating more options. One area of design that is growing rapidly is inclusive or universal design which studies adaptive technology for what used to be those with disabilities. It is now embracing a continuum approach to human needs and abilities with much interest, for example, in aging effects (Clarkson, et al. 2003). It is clear that such designs often have benefits for the “average” consumer such as ramps to buildings, and wider, better grip pens. This reflects the power of diversity that comes from more inclusive social processes in design.

Democratizing design is not straightforward. Experts exercise much executive authority. Corporate and government bosses think the decisions are theirs. Clients are sure that they should decide since they pay. And the public is not always quick to come forward because we have strongly meritocratic values.

Purely lay institutions like juries are sometimes regarded with suspicion. Yet in Denmark they have been experimenting with lay decision-making about complex issues like genetic engineering. Lay groups are formed that *exclude* experts in the areas of the science and technology being examined. At some point, such experts are summoned and they testify under questioning before the lay group. Then the lay group produces a report and submits it to parliament. These lay groups ask the contextual questions about the science / technology being examined: what will it do, what are the costs and benefits and to whom, who will own it, what does it mean for our lives, for the next generation, or for the environment. The results have been encouraging, and industries have become increasingly interested in the value of these early assessments by the general public for determining the direction their product design and development should take (Schlove 1996).

The Decision Making Process

So far it has been argued that:

- There should be a social ethics of technology because most decisions about technology are made socially rather than individually
- The social arrangements for making such decisions are variable and should be a prime subject for study in any social ethics of technology
- Two key questions about such social arrangements are, who is at the table and what is on the table?
- Enhancing cognizance is essential to ethical decision making
- Representation by stakeholders in the design process is desirable
- Diversity in the design process opens up more choices, which is ethically desirable and could well benefit both the technology and the marketability of the technology.

The process of decision-making advocated here implicitly sees technology as always good and bad. The key is to find out in what ways the technology is good and bad, and for whom. The process that is suggested is a democratic one.

In some recent views of design, a set of norms has emerged which are reputedly good for creativity; better quality, shorter time to market and customer satisfaction. These norms include openness, democratic information flows, conflict resolution, diversity, non-stereotyping behavior, listening to stakeholders, assessment of tradeoffs (Devon 1999). In general, these values derive from the democratic values of our political system and render more seamless the relationships between technology and the socioeconomic system.

Social and Individual Ethics Compared

To illustrate the distinctive nature of a social ethics approach, it will be compared with engineering ethics, which has primarily been characterized by an individual ethics approach with social issues appended via the concept of social responsibility. The comparison is provided in Table I.

Table I: Social and Individual Ethics Compared

	Social Ethics of Technology	Engineering Ethics (Individual)
Subject population	**Everyone**	**Engineers**
Target process	**Social arrangements for making decisions about technology**	**Individual accountability**
Key loyalties	**Inclusive process and cognizance**	**Fiduciary loyalty and conscience (social responsibility)**
Conceptualization	**Seamless connection to social and political life**	**Political values and processes are seen as externalities**

The debate in *IEEE Spectrum* ground to a halt over a clash of opinions and an irreconcilable disjuncture between what is ethics and what is politics. Using a social ethics framework, the differences of opinion would be treated as normal, and the idea of a boundary between ethics and politics would be rejected as detrimental to both ethics and politics. The discussion would focus on assessing the technologies and the social arrangements that produced them. Asymmetries between those who control the technology and those who are affected by the technology would characterize at least a part of this discussion.

Recent coverage of the plight of workers in secret government site, “Area 51,” in Nevada by the *Washington Post* (July 21, 1997) may be illustrative for this discussion. The workers are sworn to secrecy and the government denies the worksite even exists. According to the account, the workers are exposed to very damaging chemicals through disposal by burning practices. Their consequent and severe health problems cannot be helped nor the causes addressed, because, officially, nothing happened at no such place. While ethical defenses of weapons production exist, the situation as it is described in the *Washington Post*, reveals a problem. The problem is occurring where there is a large asymmetry in the social arrangements for decision making in technology between those who control it and those who are affected by it. A social ethics of technology provides a framework for discussing these arrangements that brings everyone to the table. And much could be done here without jeopardizing national security. A good result of such a discussion would be the generation of a variety of options in the social arrangements for pursuing the technology at hand, some of which would surely be safer for the workers' health.

Social Ethics of Technology in Practice

If the social ethics of technology is so important, it is reasonable to assume that we are already doing it. This appears to be true. A social ethics of technology is at work in legislatures, town councils, and public interest groups. Elements may be found in books on engineering and even in codes of engineering ethics. The tools are those of technology assessment, including environmental impact assessment, and management of technology. But these tools, like the social ethics of technology, are poorly represented in the university. There is no systematic attempt to focus in the name of ethics on the variety and efficacy of the social processes involved in designing, producing, using, and disposing of technology.

In education, for example, two of the best texts on the sub-field of engineering ethics address a lot of social ethics topics (Schinzinger & Martin 1989; Unger 1997). They study both means and ends, and both individual and social processes. But the subject matter is always reduced to the plight of individual engineers, their rights and social responsibilities. As the authors of one text summarize their views, "We have emphasized the personal moral autonomy of individuals" (Schinzinger & Martin 1989, p. 339). They note that "there is room for disagreement among reasonable people…and… there is the need for understanding among engineers and management about the need to cooperatively resolve conflicts" (op cit., p. 340). But this is said as a caveat to their paradigm of understanding individual responsibilities. A decade later they reiterate this view in a text with far more social and environmental issues than they had before: "Engineers must…reflect critically on the moral dilemmas they will confront" (Schinzinger & Martin 2000, p. ix). A social ethics approach would view these statements about value differences and management/employee conflicts as starting points and systematically explore the options for handling them. Further, even the emphasis on employee-management conflict is perhaps exaggerated by the focus on the individual. There are also some win-win options in conflictual situations as seen by accomplishments in negotiation and in design for the environment practices. An individual ethics approach tends to set the individual up with a choice between fiduciary responsibility and whistle blowing. This disempowers engineers and others who work in technology, by excluding alternative approaches.

In our political system, we have a great need for objective assessments of science and technology with the public in mind and involved. The demise of the Office of Technology Assessment (OTA) is much to be regretted and reflects our ambivalence about practicing what we are calling here the social ethics of technology (Kunkle 1995). The OTA was something of a role model internationally and its loss came as a surprise in many countries.

So is social ethics really ethics or is it politics? The answer is both. It is a position that clearly has political implications, and it is a position that includes, at times, a study of political processes as they affect technology. However, many other disciplines are subject to the same observations, such as economics. Drawing sharp boundaries between disciplines denies reality. Try separating civil, environmental, and chemical engineering, for example. And individual ethics also takes a political position: one which stresses individual accountability and fiduciary loyalty, and which reduces almost everything else to an externality, perhaps for the conscience to consider. That is, the individual ethics approach, as epitomized by professional codes, denies most of the contextual reality of technology and owes little to the political values of the larger democratic society. This individualized worldview, in turn, can diminish the design process technically as well as ethically. When extended by social responsibility considerations, individual engineering ethics leaves many engineers behind who view it as engaging in politics.

Aristotle states that the “good” is the successful attainment of our goals through rational action, and there is no higher good than the public good, he reasoned, because we are essentially social and political by nature (Aristotle, *Nichomachean Ethics*, Book Six, Section 8, p. 158; Book 10, Section 9, pp 295-302). Design is, in the Aristotelian sense, a science of correct action. Ethics is an integral part of all aspects of our designs and all our uses of technology. Technology is human behavior that, by design, transforms society and the environment, and ethics must be a part of it.

It has been said that Socrates set the task of ethical theory, and hence professional ethics, with the statement “the unexamined life is not worth living” (Denise, et al. 1996, p. 1). In this paper, it has been suggested that the unexamined technology is not worth having.

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Ethics Quality Management

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This paper illustrates the possibilities of institutionalizing ethical decision-making in industrial enterprises. The concept of ethics quality management tries to open a path between theory and practice by defining the (ethical) responsibility of the parties involved in the development and application of new technologies. Analogies between total quality management strategies and ethical reflection are identified and methods from Total Quality Management are adapted to the ethical reflection procedure. The present concept tries to define the responsibilities of manufacturers and users of technology according to the degree of their involvement in the process of technology design and application/utilization. Given that the social dimension of technology holds a key role in ethics quality management, the social aspect of technology will be briefly discussed in order to reveal its impact on technical design, as well as the need to include the stakeholder's perspective in industrial design. In the author's view, social acceptance of new technologies can only be achieved if this perspective is included in the design process. Acceptance of a new technology in society is the base for its commercial success. The goal of achieving acceptance seems to be the pragmatic place where ethics and economic interests play a win-win-game.

Technology, Culture and Society

Any approach towards an ethics of technology depends on the concept of the technology behind it, i.e. which form of technology we are looking at and how it influences our everyday life. In order to give a basic understanding of the conclusions derived from the TQM approach, the underlying culturalistic concept will be presented briefly.

The objective of the culturalistic concept is the fact drawn from everyday life experience, that technology obviously is a societal need of humankind. In a societal perspective, technology may be considered as part of human interaction, enabling the coordination of human actions in a collective context.

The technologies found at specific historical stages and the manner in which they are employed depend on historical processes and cultural choices of the past. This means that technologies of the past and those of the present strongly influence the development of new technologies in the future (Julliard 2003).

In a culturalistic perspective, paramount importance is assigned to the interdependency of society and technology according to which technology is a central element of culture. Culture may be defined as the know-how required by humankind to cope with everyday life. For this purpose, humans use all kinds of technology. In this sense, we live in a world that has been transformed by man through the use of technologies, i.e. a culturalized world (Grunwald 2001; Hartmann & Janich 1996). Ethical questions arise, when technologies come into conflict with interest and action possibilities of different groups of society, and/or when new technologies need to be integrated into society, as this may involve the need for society to subject itself to a learning process. The basic concept presented here can be understood as a pragmatic approach against the background of discourse ethics developed by German philosopher Jürgen Habermas (1968).

Inculturalization of New Technologies and Ethical Relevance of Technology

New technologies are successively integrated into societal practice by means of an inculturalization process. Inculturalization has recently been modeled within sociology (Bijker & Law 1994). According to the social theory of technology, technology is integrated either through infiltration or a diffusion-like process (Grunwald 2000b), where a society is allowed some time to adapt to new technology; on the other hand, the development and integration of new technologies is caused by the needs and requirements of a society. For the field engineer, the question of whether a technology has been adopted by society through infiltration or whether this process is a revolutionary one is of secondary importance; the important question is where ethical reflection and sociological aspects should play a role in today's industrial decision making structures.

A look at the industrial practice shows that the modeling of the process of introducing a new technology to society has already partly been done e.g. in the field of industrial marketing strategies, where typical life-cycle analyses of products have been established over the years (Julliard 2003).

The objective of life-cycle-analysis is to define typical product cycles. The technical details of product types change rapidly (cf. different versions of one and the same product, updates, face-lifting in the car industry etc.), whereas the underlying principles (product generations) only change over long-term periods. New technologies typically arise over decades, e.g. every 30 to 40 years, depending on the technological development. This means that the diffusion of new technologies into society is more or less a step-by-step process. Through the diffusion of new technology into society, new action patterns are created and the new technology is combined with currently used technologies and the human action possibilities linked to these technologies. Linking technologies to action possibilities creates the technological texture of a society (Julliard 2003).

By looking briefly into the stories of successful and unsuccessful products, one may conclude that new technologies require two basic prerequisites: social acceptance of the product and the possibility to be integrated into the technological texture (Rammert 1993).

Ethical questions usually arise either when new technologies affect the normative framework of a society (cf. genetic engineering) or if technologies that are being used suddenly become problematic. The social aspect of technology has been largely overlooked by technology designers of the past, but it plays a key role with respect to ethics. The objective of ethics quality management is to ensure that ethical conflicts are considered as soon as they arise. A prerequisite for the achievement of this objective is the categorization of ethical conflicts based on the impact of technology on society.

The impact of a technology on society and the need for ethical reflection in the development and application of new technologies depends on who is, in fact, affected by this technology. I suggest two basic levels of ethical questions in the development and application of technology:

a) Bilateral level. This applies to all technologies where only producers and customers are involved in the use of a given technology and no third parties have to bear the potential risks. In this case, ethical questions may be solved between the manufacturer and the customer without the participation of society. Conflicts may be settled by and between manufacturer and user.

b) Societal level. Technologies which involve changes in the normative framework of society and which involve potential risks for third parties require ethical reflection with the participation of society. Such ethical conflicts can never be decided exclusively within a company.

Furthermore, a classification of the ethical responsibility of the parties involved in technological development is required in order to determine which questions may be solved within industry and which questions require the participation of society.

Total Quality Management and Ethics

Total Quality Management is a method focusing on the optimization of industrial processes under economic aspects. The Total Quality Management approach claims that customer satisfaction is a central value with absolute priority and assumes that achieving customer satisfaction automatically implies optimal economic results. In order to reach this objective, the entire company is submitted to a continuous optimization of all procedures within: the production, sales and after-sales process, with special emphasis on how they promote customer satisfaction. Measures have to be taken to improve the complete value-creation-chain step by step and to monitor the improvements.

In short, total quality management is structured according to the three levels Total, Quality and Management. The aspect 'Total' refers to the fact that all activities of a company are included in the optimization process, i.e. procedures, staff, management activity, suppliers and customers. The Total Management approach therefore implies a holistic view of the company and its relations as well as a procedural approach by continuously developing all activities further in such a way as to increase customer satisfaction. For this purpose, the development of new technologies is a means of achieving customer satisfaction rather than an end in itself. The 'Quality' aspect refers to the objective of increasing the efficiency and effectivity of the company. In contrast to the classical interpretation of quality as 'product quality', the TQM approach considers 'quality' as a measuring device for the assessment of processes and management techniques with respect to customer satisfaction. The aim of the 'quality' part of TQM is to establish a structure in which all persons involved in the process do their job in the best possible way. The component management aims at bringing the entire company in line with customer expectations, i.e. to produce goods adapted to the customer's requirements instead of selling standardized products that do not entirely match customer needs. On a second level, management refers to the continuous restructuring of the company's procedures by checking whether there are redundancies, inefficient procedures etc. In a wider sense, the TQM strategy implies a broader view of how technology should be designed and moves from a product-oriented concept to a stakeholder perspective, which sees technology within the context of supplier, producer, customer and shareholders of the company.

In focusing on customer satisfaction as central value, a certain change in technology management paradigms takes place, as the customer regains importance as a human being, whereas technical skills are of secondary importance. Furthermore, the Total Quality Management philosophy also means that a company is regarded as a part of society with several interested parties, and therefore provides a starting point for the reflection of social implications of the company's activities.

The ethic quality management concept aims at enlarging the scope of TQM to involve the social implications of a company, i.e. more or less moving from a shareholder perspective to the larger stakeholder perspective. Total Quality Management and ethics have in common that an integral perspective is needed in order to achieve the intended goals. The process approach is mentioned in ISO 9001 chapter 0.2 as "necessary for an organization to function effectively, it has to identify and manage numerous linked activities" This is also true for engineering ethics, where it is useless if one focuses only on the ethical activity of individuals. To be effective, engineering ethics need to be integrated throughout the engineering process and involve the decision-making parties. Similar to quality issues in total quality management, ethics tasks have to be fulfilled by all members of a company. Individuals may solve conflicts as long as their responsibility, effective action level and ethical competence are sufficient to solve a given problem. As soon as individuals are no longer able to solve the conflict, they need institutional support.

Ethics Quality Management (EQM)

I suggest Ethics Quality Management as a method aimed at companies and manufacturers to take social responsibility in the development and application of products and systems. It is based on an integral view of a company in a procedural approach, including the societal viewpoint, which sees a company as being embedded in a society to whose members it sells its products.

The general task of the ethics quality management approach is the identification and structured solution of ethical conflicts in the development and application of technical systems. Ethics can be regarded as a non-material social resource for companies. I refer to the resource paradigm under two aspects. Firstly, companies need a minimum acceptability for their products to be saleable. Socially unacceptable products usually bear economic disaster (Rammert 1993).

Secondly, companies need a fixed and stable normative ethical framework to which customers and manufacturers commit themselves. The importance of this ethical framework becomes apparent where it is not employed. Companies consider a lack of security for transactions or sales processes as a financial ‘risk’ leading, in turn, to higher prices and/or smaller revenues.

The task of ethics quality management is to focus on the acceptability of technology and products as a central value. To be successful, enterprises need acceptance of their technology, users to buy them, and a positive image. Companies can get into major trouble if certain products or methods of company’s members suddenly become unacceptable. A case for this is the Shell Brent Spar Platform, where a technology suddenly became problematic with respect to society, while being perfectly ‘legal’. The ensuing boycott of Shell fuel stations led to major economic losses.

Finally, by social pressure, Shell decided not to dump the platform into the sea, although it would have been 'legal' to do so. The case led to a learning process for the company.

In a company's view, acceptability of products and systems in the eyes of society is much more important than factual product success. Acceptance of products may be limited to the company's customers, but what really leads to social trouble is when methods, systems or products become unacceptable.

It seems that, at the moment, from a company perspective, ethical questions are reduced to the question whether the portfolio is acceptable to society. Lessons learned can be a basis for Ethics Quality Management. The main idea is to let companies select certain values to reflect their own corporate culture. Of course, those corporate values should be within the range of values accepted by society. By committing all members of the company to the set of values chosen to reflect the corporate culture, companies become transparent.

The Procedural Character of Ethics of Technology

The central position of this paper is that technology design in industrial processes is done via a decentralized structure involving individual decision-making within a collective context. So far, engineering ethics has focused mainly on the actions of individuals. Classical reflection patterns in engineering ethics focused on the individual engineers and decisions they have to take, as if they were the only group involved in the design process. In my opinion, the assessment of ethical claims of technology design must take into account the whole chain of technology development and use, as a procedure from design to after sales services. Basically, ethical reflection is needed at each step of the procedure, as conflicts may always arise.

On the other hand, technology design involves many steps backward and forward, with structured checks and retrials. In the ethical discussion of technology, it has been largely overlooked so far that establishing a technical system is done in a way that includes a lot of standards and test procedures. Furthermore, new technologies usually rely on older technologies that are still being used, and that are considered as nonproblematic by society. Technical systems are elaborated recursively; a solution to a technical task is achieved by trial-and-error methods and in step-by-step procedures. Ethical reflection needs to be carried out all along the procedure, while continually asking which person has which responsibility at which step of the process. Furthermore, an ethics of technology must include the user and the problem of misuse.

Repartition of Responsibilities along the Technology Design Process

When trying to integrate ethical reflection into industrial processes, one of the central questions involved is how to socially assign the ethical responsibilities to the involved parties. I try to follow a pragmatic approach by using the method how technical responsibility is assigned analogically for ethical responsibility. Whether this claim is suitable is, of course, subject to further investigation. The repartition of responsibilities follows the idea of assigned responsibility as a means of constructing responsibility by social ascription (Grunwald 2000a). Social ascription of responsibility may be done without considering personal fault. Following this concept, not every engineer has to continually think about all ethical tasks of the entire company, nor how he may take a global responsibility for the world upon himself, but he has in fact a limited responsibility, depending on his function and level of action.

It is the *responsibility of top management* to define the company's mission, its vision and the binding values for the enterprise. In doing so, it also defines the worldview to which the company subscribes. For big companies it may be advantageous to spread this definition on a global level, in order to define, both for the company as a whole and for a local area, which precise values are binding for specific situations of working groups and their respective working area. In multicultural holdings, it is even possible that global values are accompanied by a set of culture-dependent values, which are binding for national divisions only. Note that it is very important for global and local sets of values to be consistent. It is very important that global sets of values do not interfere with local ones. Furthermore, top management should consider a systems perspective that plays a role in the definition of goals and long-term strategies for the companies as well as long-term decisions. In those decisions, the social aspects are absolutely vital, due to the importance of acceptability. A company's top management has to establish a framework that enables ethical decision-making by the staff and fosters ethical behavior of individuals. It has the ascribed integral responsibility for the company and its actions. Beyond the central responsibility of the top management, further areas have typical responsibilities. Generally spoken, the potential for alternative solutions decreases with ongoing technology design; therefore, ethical questions mainly play a role in the early project stages, where basic decisions about technological lines are made.

The *sales staff* works in an ethically sensitive area of technology development. They are responsible for a suitable choice of technology. As product specifications and the choice of a specific technology are closely related to values and strongly influence the actual technology development, ethical reflection is important. Corrections and changes in the product profile can be implemented much easier at an early stage of project management.

Typically, the potential for action and correction decreases with time. In the definition of constraints and performance of a technology, worldviews play a key role. For example, the design of a control system depends on whether this user is an expert or not. Depending on this, a product could be designed either in a failsafe version, if users are experts, or in a foolproof version. Moreover, perceptions of society of the future play a role in defining overall concepts (Bijker & Law 1994). Examples for this are the ecologically friendly society, paperless offices etc. It is extremely helpful if these views of society are explicitly defined within the company's code of conduct. More precisely, on a first level, the sales staff has the responsibility to ensure that the chosen product matches customer's expectations and is appropriate for the area of intended use. Therefore, customer requirements have to be identified and product constraints have to be defined. The societal perspective is that products must comply with the actual technology that is currently being used; further development may be necessary if problems with products in use arise. Furthermore, the sales staff may be considered as a warning and supervisory body. It may elicit a possible non-acceptance of technologies and, if necessary, take steps towards a further development of technology, or for entering into discussion with stakeholders who regard this technology as problematic.

The *basic and detail design working group*, which has to work out the technical system's basic and detail design, as well as the scope of works, is, perhaps surprisingly, not an area of special ethical sensitivity. It has to design the technical system according to the system specifications defined and agreed upon by the sales department and customers. Design engineers therefore are responsible for the material aspect of technical development (Moriarty 2000). If product constraints are clear, it is even possible that this group will not have to deal with ethical questions at all. Due to unforeseen and suddenly arising questions concerning the design, it may be possible that design engineers have to deal with ethical questions, when decisions are taken which refer to choices between alternatives. To a lesser extent, design engineers may be committed by society to design technology in such a way as to facilitate future improvement. Such a technology would be suitable for further development and can be seen as a starting point for sustainable development.

Test Laboratories in industry are a central area of ethical responsibility in societal perspective. Test labs have the responsibility for the engineering process ex-post. Technical systems are tested under ordinary and extraordinary conditions, as well as for the case of failure. After design and pre-qualification tests, systems are tested before they are shipped to the customer, and are tested again, at the commissioning stage, before being accepted and taken over by the customer. Frequently, the operation itself is preceded by several months of reliability run. Therefore, it is a myth that engineering ethics would be only a matter of concrete decisions of one individual. On the contrary, technology development takes place according to a recursive strategy.

Test procedures are part of that recursive strategy and systems undergoing the test procedures have to meet all kinds of requirements coming not only from inside, but also from outside a company. If a system does not meet the specifications defined in standards of customer, engineering associations and the manufacturer himself, new steps in design can be taken and the system may be improved by this procedure. In separating the design step from the system test step, and in assigning the different tasks to suitable staff, it is less likely that failures will not be discovered. Test labs have the ethical responsibility to check whether or not the test procedures defined in standards are adequate for the technological product that is being tested. If the test procedure is inadequate, they have the duty to inform superiors and the respective authority defining this standard. For entirely new technologies, test labs must define the test routines themselves and may be obliged to assist engineering associations and national standard boards in their work (cf. the working groups and Task forces in organizations defining those standards) The duty of test labs may be enlarged with respect to a societal perspective, where test labs and marketing should be obliged to check whether or not new technologies may be integrated into societal practice.

Commissioning, under ethical aspects, is a matter of correct risk transfer and is usually an ethically non-sensitive area, if all other areas involved have functioned correctly so far. Methods of correct risk transfer have been used in the past e.g. procedures for putting technical systems into operation step by step. Engineers in this area have the duty to familiarize users with the said technology and to prevent foreseeable misuse.
The *users* are responsible for the use of technology and for all negative effects resulting from the use of technology beyond its area of application. Users must be able to control their chosen technology and employ suitably skilled and qualified staff to work with it. Furthermore, their tasks also include maintenance and correct dismantling of technologies. If the problem of a non-acceptance of technology by society arises, they have to initiate a discourse process involving society and manufacturers.

Structures and Institutions

In order to assign the responsibilities along the technology development process, several institutions are necessary. These institutions should foster ethical action of individuals and coordinate conflict-solving processes. The main idea is that conflict solving should only involve parties affected by this conflict, and that it should be done in a structured way. The following draft for institutions in ethics quality management has to be discussed in the future and it might well be that structures need to be modified again and are not suitable for every company. In the following I refer to a case study in a systems engineering company working with computer systems, but the EQM idea has also successfully been applied to other areas such as paper industry.

At an *individual level*, EQM requires ethically educated engineers and other staff members. The level of ethical education should correspond to the level of action of an employee. Engineers do not need to be ethical experts, but they need a minimum of ethical understanding in order to be able to identify conflicts. All members of a company should be committed to the common ethical standard of the company and/or to the standard of their professional organization. The main task of individuals is to identify and communicate existing or arising conflicts. They may also solve ethical conflicts, if those are of the business-as-usual type problems that can be solved by individuals. Whether this is the case, or whether a given problem can only be solved by a larger group has to be defined in the company's standard of ethics. As members of society, individual engineers should be able to provide technological counseling for society. Help-lines may be necessary for anonymous calls.

Ethics Task Forces are the next institutional level. Ethics Task Forces consist of a group of engineers working in the same area. This task force reflects a kind of miniature society. Task forces have to define and adapt the global values of the company into the concrete situation.

In doing so, they define a kind of groups ethics for working groups. Furthermore, they have to solve all conflicts that may not be solved by individuals. Members of the task force need enhanced ethical education. In the case of a conflict, the person reporting the dilemma joins the ethics task force. Conflict solving is either done by the task force itself using discourse methods and recording the conflict-solving process by means of the documentation database or by including further experts into the decision-making process. If the conflict vitally affects society and/or the company, the task force applies for help from the EQM public relations group and the Ethics Officer. Those conflicts should be treated isolated from the person reporting the conflict to prevent damage for the reporting person. Furthermore, ethics public relation may decide whether or not the conflict can be solved on a corporate level. Conflicts involving societal tasks and the inclusion of stakeholders have to be solved in a discursive manner with the aid of the public relations division.

The *Ethics Public Relations Group* acts as an interface between society and company; its task is to include the stakeholder perspective into the engineering process. Firstly, this group defines the values, worldviews to which the employees of a company are committed. Secondly, it has to monitor the groups ethics defined by the task forces with respect to their compatibility to the general company standard. Moreover, it manages conflicts that cannot be solved by the task forces and may even decide to attract the conflict solving in cases where engineering ethics problems need participation of stakeholders. In this case, the duty of the public relations group is to invite discussions with the public. It is of great importance that the ethics public relations group is independent from the human resources department in order to prevent negative consequences for the employees reporting ethical conflicts. On a second level, the ethics public relations group informs the public about conflict solving within the company and is open for questions from customers and for those of public interest. In this way, transparency to society with respect to ethical decision-making within the company is created which enhances the acceptance of the company and its product. The group is the institution for holding "paramount the safety, health and welfare of the public"(IEEE Code of Ethics). The group is supported by the EQM monitoring system. The ethics public relations group also monitors and discusses the ethical framework of the company and reflects it regularly in order to develop it further on if necessary. Philosophically spoken, this group belongs to the reflection level in ethics.

EQM Monitoring and Documentation finally has to establish and manage a database where all ethical conflicts and the found solutions are recorded. The database should be structured in such a way as to facilitate research into and profiting from similar conflict situations. Ethical conflicts should be classified and archived with the solution found for each conflict. This can be understood as a learning process for the company where employees and task forces can learn from the knowledge and experience acquired by others in ethical conflicts. Furthermore, the database is a control tool for the management of ethical conflicts within the company and may be used for transparency to society. This database can be used in auditing the employees in regular cycles. Another task of the public relations is monitoring inculturalization processes for the company's products and taking part in the strategic consulting of society, if questions about whether or not a technology should be used arise.

The *ethics officer* has to coordinate and supervise ethical behavior and actions of the entire company. He takes part in decision making of the EQM public relations. On a further level, he is responsible for ethics management. He is a member of the top management and acts as an interface to professional societies. Furthermore, he is the contact person for the public.

Classification of Ethical Conflicts and levels of solvability

According to Armin Grunwald (2000b), ethical conflicts in engineering may be differentiated into *business-as-usual* conflicts and *Engineering-ethics* conflicts; they require different conflict solving strategies. Business-as-usual conflicts refer to types of situations where the normative framework is not affected and the choices of values are clear. In this case, there is no need for reflection about new ethical categories or strategies, but conflicts may be solved by classical prioritization of values and through a straightforward approach of ethical rules to the situation. Business-as-usual means that ethical decision-making based on rules and prioritization strategies for rivaling values is possible. Such conflicts can usually be solved by relying on codes of conducts or engineering ethics codes and the principles stipulated in these codes. I do by no means wish to imply that in these cases ethical reflection and behavior is not necessary at all, but I simply wish to point out that there are well-established conflict solution strategies for those cases. Business-as-usual conflicts may be solved by engineers or groups of engineers within their companies under certain circumstances. Generally speaking, they are more or less trade-offs between rivaling values.

Engineering ethics conflicts are conflicts that cannot be solved simply by the application of prioritization rules, but which need reflection of ethical values and strategies themselves. More generally, they imply a reflection of ethical theories. This is generally the case with all conflicts where the normative framework of society is affected, or third parties are involved into the conflict. In this case, there is a need for the participation of societal groups in the conflict solving process and the conflict is no longer solvable within a company alone. Building a solution for such conflicts implies both knowledge about technical tasks and knowledge about ethics. In these cases, the construction of an appropriate solution is a task of interdisciplinary reflection and decision-making. It may be

necessary to develop the normative framework of society further and /or develop technology further in order to obtain sound solutions. This may imply that engineers take part in a political decision-making process. Engineering ethics conflicts almost always imply societal participation.
Including the reflection about the levels of ethical questions in section 2 and the types of ethical conflicts in the section above, I suggest a total of four types of ethical questions within the process of technology development and inculturation:

aa) bilateral business-as-usual conflicts.

Minor conflicts without risks for third parties may be solved on an individual level if they are of the business-as-usual type. In this case, the design engineer may decide how to solve the conflict and manage the trade-off between the values by himself, by using prioritization rules and principles included in ethics codes. If he does not wish to solve the conflict himself or if he is not sure that he can deal with the conflict, the next level for the solution of this conflict should be the ethics task force. If risks for users are involved, a discursive process with the user should be launched. Any decision will be registered by the EQM Monitoring system.

ab) Society-relevant business-as-usual type conflict

Society-relevant business as usual conflicts need the participation of third parties exposed to the risks of technology and do often appear in the early inculturation stage. If technologies do not affect the normative framework of a society, users need to be involved to achieve a better acceptance of technologies. A differentiation between conflicts that can be solved by technical developments within the expected time schedule of a project and conflicts that are not solvable within this schedule may be necessary in order to assign responsibilities for conflict solving. Conflicts involving long-term reflection and which cannot be solved within the specified time may not be solved within companies; they are a task of society and need not be reflected upon within the industrial process. For instance, the 100% environmentally friendly production of electric energy is an ethically desirable goal, but is not achievable within a short-term schedule of 5 years, due to technical constraints and the large involvement of electrical power in societal practice. The normative claim for environmentally friendly energy is useful in so far as it defines a long-term task for society, but it is not useful for decisions about short-term power production strategies. If this is done, it leads to utopian demands resulting in apathy. Such utopian requirements are not helpful for short-term decisions and therefore cannot play any role in practical engineering, because they do not lead to other design requirements, and therefore are useless.

ba) bilateral engineering ethics type conflicts.

Bilateral engineering ethics type conflicts usually arise if a technology is used by a limited number of people and system constraints are obscure and/or affect the normative framework of society. It should be explicitly mentioned that no third parties have to bear any risks. In this case, conflict solving should include the manufacturer and the customer; society should be informed by EQM public relations. An example for such a conflict is the use of cellular phones and the risks of exposure to electromagnetic radiation. Here, there is still unclarity about the dangers related to electromagnetic radiation and whether the levels of exposure specified by the standards are really below the damage threshold. On the other hand, cellular phones are becoming a well-incultured technology.

bb) society-relevant engineering ethics conflicts

If the conflict is of engineering-ethics-type, it may involve questions about the normative framework of society. In that case the conflict is no longer solvable within the company but needs the participation of stakeholder groups. Conflict solving therefore has to be done on the societal level and should almost always include discourses with the groups affected by the (new) technology. Companies may take part in this process, where they may advise policy-makers and society members about advantages and risks of new technologies. It is an ethical imperative that this should be done in an open and fair manner. At the moment, the designing engineer himself implicitly carries out social and ethical reflection in technology design to a large extent. The integration of a society perspective is restricted to the marketing activities of a company, where market potentials and acceptability of products are analyzed. In a societal view, this activity is largely limited to users of a technology and does not directly involve third parties that do not profit from a technology, but have to bear its risks. This is an ethically sensitive case. It needs participation in discursive processes. An actual case is the use of cloning for reproduction purposes, where it is not yet clear whether society actually wants cloning and where other ethical questions arise, e.g. questions about the value of human life, whether it is desirable to eliminate gene damage before the implantation of a fertilized ovum into the uterus etc. These conflicts may never be solved by the technology-producing company alone, but require a societal perspective. On the other hand, companies can get into trouble when techniques in the phase of introduction suddenly get socially problematic (cf. GM-food in Germany and the Netherlands). Companies and society can play a win-win game if the socio-ethical dimension is discussed all along the design process and measures are taken for a smooth inculturation of new technologies.

Proposals for a Standardization

The society in its relevant institutions needs to develop a dialogue about which ethical duties it assigns to companies and the values and paradigms that are imposed on companies by society. Standards might be one way of introducing instruments for ethical reflection into the engineering process. This has already been done within the field of quality management with respect to the value of "quality and consumer satisfaction." In quality management, almost every company needs to be certified according to the ISO 9000 system. Hence, it seems possible to extend this ISO system to ethical standards and values. The standard is a matter of assigning social responsibility to companies. Companies may elect the values they commit themselves to. Preferably, values should be chosen according to existing standards like the VDI 3780 Technology Assessment. Institutions and monitoring processes should be prescribed, as presented above. Auditing and control procedures should be executed by central authorities on a regular basis. The standard may include participation of stakeholders where necessary. The advantage of this course of action is that QM Systems are accepted in industries to a large extent, and the institutions already existing may be used for this purpose. Companies do not wish to lose their QM standard certificate.

Conclusion

This contribution is a first reflection on the question of 'how to enhance ethical decision-making in the industrial context' by including a stakeholder perspective into technology development. This is only possible if the development and application of a technology is seen as part of a social process. This approach implies that one has to abandon the principle of discussing engineering ethics only through an individual perspective with respect to ethics codes. The objective of the ethics quality management approach is to investigate project management and the responsibility distribution within this process in order to determine possibilities of enhancing and fostering ethical decision-making. A division of labor between society and industry seams necessary where long-term planning on the macro-level is done by society, whereas industry is largely involved in short-term planning and the micro-level of reflection. At the corporate level, different institutions are required in order to promote individual actions in collective decision-making. In Quality Management, institutions have already been established which have developed suitable strategies for supporting ethical reflection. Furthermore, the structural analogies between quality management and ethical reflection processes are used to introduce the social perspective into the design and use of technology. Whether this approach is effective or not largely depends, like all TQM strategies and company cultures, on its support by the top management. EQM is only effective if it is taken seriously and if it creates transparency for society. Therefore, standardization may only help to foster the process, but it does not mean that all problems can be solved simply by means of standardization. A large amount of investigation, especially with regard to ethical decision-making and technology development, still needs to be carried out. Questions like rules for responsibility-distribution and assignment to the different actors in the process of technology development and use need further research. Furthermore, the role of companies as the developers of technologies and - through technology- as the developers of culture requires closer attention with respect to the resulting ethical obligations.

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