3 PRINCIPLES FOR MANAGING RISK IN THE PUBLIC INTEREST

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ABSTRACT

We propose three principles and a general framework of reasoning for managing risk in the public interest.

Principle #1: *Risks shall be managed to maximize the total expected net benefit to society*- The principle that the net benefit is to be maximized across society as a whole is argued to be a sufficient and rational guide to assessing the effectiveness of efforts directed at reducing risk and thus improving health and safety. The net benefit of an activity is the excess of the totality of benefits over the totality of detriments.

Principle #2: *The safety benefit to be promoted is life-expectancy*- The goal is to ensure that risk mitigation efforts maximize the net benefit to society in the specific terms of length of life for all individuals. The effect of an activity on life expectancy is proposed as the proper basic measure of its net safety impact. Life expectancy is a universal measure valid for comparisons both within and among countries and can be adjusted to include health expectancy and other factors such as income levels that affect the quality of life. The impact on life expectancy allows a dispassionate accounting of the good and the bad inherent in any proposal or activity that is in the public interest but has some impact on life and health.

Principle #3: *Decisions for the public in regard to health and safety must be open and apply across the complete range of hazards to life and health.*- Systematic efforts to evaluate *all* the important consequences, both direct and indirect, are required to improve the basis for risk management in society. Balancing of the detriments *and* the benefits of any given initiative is the key aspect of the undertaking. Safety may well be an important objective in society, but it is not the only one. Thus, allocation of society's resources devoted to safety must be openly and continually appraised in light of other competing social needs because there is a limit on the resources that can be expended to save lives. Maximization of healthful life for all is judged the proper basis for managing risk in the public interest, and that this is achieved when the net of the contribution to the total saving of life exceeds the loss of life.

List of key words:
Managing Risk, Public Interest, principles, societal benefits, life expectancy, healthful life

1. INTRODUCTION

We propose three principles for managing risk, directed at decision-makers responsible for ensuring the health and safety of the public. The prospect of disease and death can be emotionally upsetting, especially when the sick or dying are near and dear to us. Human nature makes it easy for people to react in alarm. But if there is anything we have learned in these areas, it is that unreflective alarm leads to bad practice. The principles are broad statements intended to assist the future development of the more detailed and case-specific guidelines so that decision-makers can deal effectively with the problems of managing of risk to life and health that best serves the public interest.

In proposing these principles, it is of the first importance to appreciate that most human activities directed at the creation of wealth confer both benefits *and* detriments upon different members of society. In most cases, at least some of the benefits and some of the detriments are indirect and uncertain and fall to different degrees on different members. Those risks and the benefits cannot be predicted *a priori*, nor can we completely eliminate the sources of uncertainty that bedevil our decisions. The principles and the reasoning described below can be used to improve risk management practices.

2. RISKS: AN OVERVIEW

We are privileged to live in a modern technological society that is wealthier than any previous generation of humankind anywhere. We can, in addition, expect to live longer and to live in better health. Yet, it seems that we worry increasingly over risks to life and the environment arising from technology. Everyone is understandably concerned about the hazards of new technologies, and it is unsurprising, but unfortunate, that these concerns often dominate the discussion. Catastrophic failures command attention because they are newsworthy. The failures may or may not involve loss of life but often involve large financial losses as well. Such failures may include failure of structures (i.e., dams, public buildings, bridges), transportation systems (aircraft, rail, car or oil tankers) or accidents at major industrial installations (petrochemical facilities, power plants). Safety of consumer products, pharmaceutical products, agricultural practices (use of pesticides, fertilizers) and myriad other concerns also occupy the public agenda.

2.1 The Zero-Risk Fallacy

These concerns tend to generate a demand for safety that in effect is a demand for a *zero* level of risk. This, in turn, leads to costly or even tragic decisions. Often the expected returns from the safety features demanded are so tiny and their costs so large that people end up much less safe, and not merely poorer, than they would if a wiser policy had been followed. The beginning of wisdom in these matters is to appreciate that no option comes without a price tag: we reduce risk in one direction, but unbeknownst to the policy-makers, we increase it in another. *There is no such thing as perfect safety, zero-risk.* To try to build that target into the mandate for a technological package is to succumb to illusion, and the illusion can be enormously costly. Those costs in turn translate into nothing less than wasted lives.

Thus, there is an important role for the risk manager to provide clear, unambiguous guidelines where there exists a need to ensure achievement of an optimal level of overall safety. The engineering of human safety is in essence decision-making under uncertainty. Thus, there is always one course of action that will yield the maximum benefit, given the existing state of knowledge. The uncertainty is, in essence, embedded in the state of knowledge relevant to the assessment of the problem at hand.

A further point to emphasize is that technology is far from the only source of risk to health and life. It is, in fact, not even the primary one. New technologies, while they carry some risks with them, also *reduce* risk; indeed, that is the normal effect of technology. The automobile, for example, kills thousands per years, and injures even more. Yet its effect is on the whole to *increase* life expectancy and health. The automobile speeding the stricken patient to a hospital saves many more lives by getting there in time than it loses by being involved in an accident on the way. The motor vehicles that deliver our food before it rots promote our health, despite the occasional accident. Reducing motor accidents to zero by abandoning the motor vehicle would result in a decline in the expectancy and quality of life for all of us. That is but one example, though a very important one, of the tendency in question.

A major goal in the development of socially responsible control of technologies is a thorough accounting of all the benefits and detriments arising from the use of any specific technology, plus the formulation of appropriate ways of weighing specific risks and benefits. In the absence of a disciplined consideration of both risks and benefits, we are bound to have an unbalanced weighting that will result in wasted resources and shortened or unwell lives. Such discipline is time consuming and requires sober reasoning and a refusal to be guided by slogans.

2.2. Problem Statement

One direct consequence of uncertain and erratic risk management is expenditures of large sums on schemes that do not appreciably reduce risk. A further direct, and significant, consequence of this is that lives are needlessly lost, since numerous more effective life-saving schemes are not undertaken. So serious is this point that it in many cases no government action may serve the public interest better than command and control legislation directed at controlling risk.

The difficulties in arriving at decisions, whenever safety is viewed by the public to be an important consideration, arise from several factors. Two important factors are:

(i) No disciplined and systematic effort is made to find the appropriate balance, or compromise, between risks and benefits (including considerations of equity) because the established levels of safety lack uniformity of application. Safety levels are determined by mere expediency, which nevertheless acquires the force of law.

(ii) The assessment of factors that contribute to the overall net benefit is generally ignored resulting in large sums being spent with the further consequence that real safety is compromised.

Specific examples highlighting the problem, and examples of policies for control of risks and cost effectiveness of risk reduction schemes have been described by several researchers (Tseng et al 1994, Viscusi 1992, 1993, Breyer, 1993, Lind et al., 1991a, 1991b, 1992; Nathwani et

al., 1992; United States, 1991;Morrall, 1986; Cohen, 1980; Graham and Vaupel, 1981; Siddall, 1981). The examples cover a wide range of activities subject to engineering risk control strategies that include highway safety (air bags, seat belts), emissions standards in the work place (such as coke ovens or benzene regulations), medical and health programs (kidney dialysis, cardiac treatment units), coal powered plant design features to control emissions to the environment, nuclear safety features, pharmaceutical and consumer products.

The determination on the part of politicians to manage resources wisely has certainly been clear. For example, for over a decade subsequent governments of Canada have decreed that comprehensive social and economic impact assessments of important regulations should be performed. The Guiding Principles of the Regulatory Reform Strategy (Canada 1986) state that

"... regulation entails social and economic costs, and the government will ... ensure that benefits clearly exceed costs;

... the government will not use regulation unless it has clear evidence that a problem exists, that intervention is justified and regulation is the best alternative open to the government ... the government will ensure that officials are held accountable ...."

Effective implementation has proven to be quite another matter. There is still little consistency among agencies in the way hazardous technologies are managed. The very serious end result is that both lives and resources are being wasted. A rational strategy for risk management is required because there is a good potential for improving the effectiveness of spending directed at health and safety concerns.

2.3. The Need for Balance

Currently, public safety policy is influenced heavily by perceptions of detriments. Such perceptions at best only capture transitory shifts in preferences and are critically dependent on graphic imagery, rather than balanced assessments. When isolated bits of information are uncritically passed on by the mass media, they tend to distort the reality underlying a given risk; and when the message is seen by legislators and decision-makers, erratic policy responses are the inevitable result. A disciplined and systematic search for the facts and evaluation of options, being time consuming, has less appeal and is therefore ignored.

Legislators are committed to serving the public interest, but they are unable to do so in many circumstances since there is no reliable and clear basis on which they might proceed. This is because perception of hazards, sensationalism, vociferous interest groups, questionable motives and "hidden agenda" dominate public discourse on such matters. A more important observation is that even within the professional risk assessment community, the necessary protocols and approaches to management of risk have not evolved to a sufficient degree of general acceptance that they can provide useful guidance to legislators. This paper is intended to make progress in rectifying that situation.

2.4 Philosophical Considerations

When any individual, Ms. Jones or Mr. Smith, undertakes any activity, the hope is that she or he, and perhaps some others about whom that person is concerned, will achieve some benefit. There is also some chance of detriment: not only that the hoped-for benefit won't be realized after all, but also that some actual injury or disease, even death, will come about as a result. However, what further complicates life, and what creates the case for public consideration of these risks, is

the fact that not only will Ms. Jones herself be exposed to some risk as the result of her undertaking, but quite possibly so will someone else, say Mr. Smith. That is where the serious problem of justifying policies begins.

It is a large part of the heritage of Western civilization that the ultimate balancing of the specific benefits and detriments to Ms. Jones herself are fundamentally her own business.[1] It is not for us, public servants or engineers, to tell her how to run her life. Does she insist on taking up smoking? Science can, and should, tell her that to do so will take a sizable toll in life expectancy. But it is up to her to decide whether she will live a shorter, smoke-filled life or a longer, smoke-free one.

There is also an equally important part of that heritage -- a part shared, really, by all known cultures -- that the risks she imposes on *others* are no longer strictly "her business." Just as Ms. Jones's life may be agreed to be her own business, so Mr. Smith's life, with its particular balance of benefits and risks, is *his* business. So when an activity of Ms. Jones affects Mr. Smith, or vice versa, there is need of a reasonable set of guidelines for the interaction. At what point may Mr. Smith insist that Ms. Jones refrain altogether from her proposed undertaking, on account of the risks to him? Especially there is the question, at what point may he call upon the services of a potentially coercive power, government, to make her cease and desist, or to modify her ways? This question, generalized to all members of society, is at the root of our concerns in this proposal. It is well to become clear at the outset about the justification for appealing, as we do, to a notion of the *net benefit of society* as the basis for answering such questions, for that idea may well sound nebulous or suspicious, or both, to the wary reader. We pause here, therefore, to state, in brief, the philosophical justification of our point of view.

Two major questions arise from the foregoing. First: why are we discussing aggregate benefit to a group? This is the point of view known as classical utilitarianism[2]. It has been very popular and influential, but it has come to be recognized that there are severe problems with it. It is certainly not the natural view of any individual. Individuals seek their own benefit and that of selected persons -- friends, loved ones, associates in particular causes. They do not willingly undergo some loss - say, a monetary one - in the interests of the benefit of some large group of miscellaneous unknown persons, even one of which they are members, let alone such a nebulous entity as humankind en masse. Philosophical attempts to ground departure from this natural point of view have been unhelpful[3]. We must have policies that make sense to people as they are, not as some theorist thinks they should be.

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[1] [John Stuart Mil, An Essay On Liberty, is a classic formulation here.]

[2] The classic sources on Utilitarianism are: Jeremy Bentham, Principles of Morals and Legislation; John Stuart Mill, Utilitarianism, and On Liberty (there are many editions available, one is Garden City, NY:Doubleday & Co., 1961) and Henry Sedgwick, The Methods of Ethics (now published by Hackett). For two modern writers, see Jan Narveson, Morality and Utility (Baltimore: Johns Hopkins University Press, 1967) and Russell Hardin, Morality Within the Limits of Reason, (Chicago: University of Chicago Press, 1988). There is an enormous critical literature on Utilitarianism in the philosophical journals and monograph literature. For a single, compact and in our judgement devastating critique of the general idea, see David Gauthier, "On the Refutations of Utilitarianism," in Harlan B. Miller and William H. Williams, eds., The Limits of Utilitarianism (Minneapolis: University of Minnesota Press, 1982, pp 144-163).

[3] For what I now regard as a failed effort, see Narveson, Morality and Utility, Ch. IX-- pp.257-293. On why it fails, see Gauthier, "On the Refutation of Utilitarianism."

The second question is, Why choose the value of healthy life, or quality-adjusted life? Are there not things that matter more to people than mere life, even if it is healthy? Will not people sacrifice life for the sake of things they consider more important? These are important questions, and their concerns well-taken. Fortunately both can be answered. In fact, the answers are interrelated, and the interrelation reinforces our confidence.

In response to the first question, the problem is this. Classical utilitarians proposed that the general criterion of rightness was maximization of overall utility, the sum of all individual utilities, regardless of distributional implications. Utility was typically identified with happiness, pleasure, or perhaps satisfaction. Among the main objections to that theory was the admitted impossibility of making the kind of measurements that would be required, in principle, for applying it. There is even doubt whether they make any sense at all[4]. Our project, however, attempts no such thing. We do not aim at maximizing general utility as such. Instead we confine our attention to the promotion of *health*, which, while it has its own problems of definition, is nevertheless practically definable for a very large range of cases and persons. Besides being practically definable, it is universally desired at the individual level. There is no dispute among people as to whether lung cancer, heart attacks, severe burns, or Alzheimer's disease are evils to their victims.

There is, of course, dispute whether the sort of healthiness involved in being able to run twenty kilometres a day is something we should all be striving for. But our proposals do not presume to insist on setting such disputable levels of well-being. Such choices are properly up to the individual. Yet no one regards it as seriously doubtful whether exposure to the risk of death, disease, or injury is an evil to be avoided. No one seriously doubts that it is worth some effort, trouble, and expenditure to reduce such risks. *How much* trouble is the question.

Why is there virtual unanimity on the desirability of basic health? There are two compelling reasons. First, ill-health of all kinds interferes with our pursuit of the kind of life activities we would like to engage in, *virtually irrespective of what those activities are*. Be we fisherfolk, coal miners, professors, merchants, poets, or whatever, we shall perform less well or, in the limiting case, not at all, if we are afflicted with Parkinson's disease or yellow fever or, of course, in the ultimate limiting case, death. Thus the matter of whether health is a good is virtually unaffected by our choice of lifestyle, by our interests, tastes, and desires.

Another consideration assuring something near to universality on this value is nearly as compelling. That is, that disease in virtually all cases involves *pain*. To be sure, we can distinguish between specific physical pains, which are universally regarded as evil, and many related aversive states such as discomfort, distress, irritation, disgust, despair, and so on. Though more diffuse and much harder to incorporate into risk analysis, we are safe in presuming a shared aversion to all such conditions on the part of virtually any member of the public. In any case, the proposals we make are largely concerned with the first type. In fact, they are most of all concerned with death, and thus with life-threatening diseases and injuries, and with physical incapacitation, both of which are mostly easy to measure.

Thus the value we seek to promote is one with a quite great degree of measurability and an overwhelming degree of universality. A good deal of the measurement with which we will be

[4] For a clear and sympathetic but rigorous discussion, see Hardin [1988], Ch.5

concerned, however, has to do not with the *intensity* of given afflictions, but rather with their *probability*. It is here that the peculiar importance of the discipline of Risk Management lies.

We must also distinguish here between the encountering of risks from sources over which the individual has no or little control, and those over which he has substantial or complete control. For example, cigarette smoking exposes the individual to severe but avoidable risks. On the other hand, passersby and other fellow occupants of public places may be exposed to risks from other people's smoke, without seeking or wanting such exposure. In the interests of safeguarding public health risks, we may consider regulation of smoking in public places, but not in strictly private ones where individuals' smoking activities expose no-one but themselves to appreciable risk.

Now, all of us are liable to the assorted ills of the human physique at the hands of randomly-encountered factors in our environments. We are, moreover, very broadly speaking fairly equally vulnerable to them. We may vary in our sensitivity or susceptibility to certain particular diseases, but taking the broad range into account, our liability is not dramatically different for normal individuals.

Taking into account these factors, it becomes credible in this field to propose that we have, by and large, a common interest in the reduction of publicly-encountered risk to health and the concomitant promotion of (healthful) life. The hypothesis is that because of the extensive interaction with others so characteristic of modern life, all of us are risks to others, and others are risks to us. Thus the individual seeking to maximizing her <u>own</u> healthy life does well to share in programs of reducing public risk from miscellaneous causes. That is what bridges the crucial gap.

But there could be cases in which identifiable individuals would be exposed to great or fatal risk in the effort to reduce risk to people in general. Those cases, we emphasize, are *specifically exempted* from the scope of our principles. The public management of risk balances low-level risks to people generally, not to known and identifiable individuals or groups. Wherever the assumption of general imposition and recipience of risk breaks down, affected individuals must be treated separately. On no account may we "sacrifice" identifiable individuals to the "greater good of the group."

The choice of healthy life is important. There is much discussion nowadays of the propriety, let alone the value, of taking extreme, and extremely expensive, measures to prolong life in cases of advanced age or extreme condition. From our point of view, we here again depart from the arena of our main concern. It should, we may agree, be up to individuals whether to fight on in conditions of extreme pain and suffering with no prospect of substantial remission. We may also regard public funds expended for that purpose as not well spent. Our concern is with risk to otherwise healthy individuals, people who would be able to carry on with their lives on terms satisfactory to them, but for the fact that they are struck down with cancers, heart attacks, and so on. When people are afflicted with activity-inhibiting specific conditions whose incidence can be reduced by public measures, but not so easily or not at all by the actions of individuals on their own, then we are into the areas where rational risk management becomes of interest to all of us.

The programs we propose, then, must appeal to all individuals in their own right. Those who are part of the problem - on occasion virtually all of us - may properly be required to alter those activities that expose others to undue risk. And the expected beneficiaries - again, all of us - have ample reason to support the kind of measures we will be advocating. Each of us stands to gain from membership in a society where effective principles of the kind we propose are

employed. No more need be asked of a normatively significant undertaking to render it philosophically satisfactory.

Why should an individual be compelled to accept even a tiny risk in the interests of promoting the health of others? This too has a persuasive answer. The short answer is that he should *not* be: if someone is genuinely immune from a given risk, and no part of its cause, then it would be wrong to wrest from him any contribution to its reduction. But then, we have to point out that *everyone* lives in a normal environment of appreciable risk of various kinds.

When some act of another individual or group is known to entail a tiny increment of a specific risk, two points have to be made. The first is that in that case, the individuals exposed to it will not even be able to identify the net marginal increment of risk to themselves. And only net increments can have any standing in this consideration. It is irrational to be concerned about subliminal alleged increments of risk. Nor is it in point to reply that when multiplied by many millions, such increments become significant. For if such a risk would not be worth the expenditure of any appreciable cost in any particular life, then even though, say two or three lives might be saved in a population of millions, the cost of saving would be astronomical relative to the benefits. And that in turn means, as is pointed out below, that we would be losing more lives than we gained in devoting so many resources to the saving of those few. That is indeed, quite strictly, irrational.

Second, were this consideration to be sufficient reason for desisting from the activities in question, then all persons, including our hypothetical "victim," would have to cease virtually all activities. This makes no sense and would, of course, result in a catastrophic decrement in the very values - of high quality healthy life -that we all want to promote, at least in our own cases.

3. 3 PRINCIPLES FOR MANAGING RISK IN THE PUBLIC INTEREST

In managing risk, the objective should be to serve the public interest in a rational manner. The immense base of knowledge issuing from the scientific and engineering community provides us with the resource required to assess alternatives for the decision-maker, once the proper normative framework is supplied. The needed framework for sound risk management is found, we believe, in the following three principles:

3.1 PRINCIPLE #1:

Risks shall be managed to maximize the total expected net benefit to society.

The principle of maximizing net benefit for the collective has been expounded by philosophers and economists since the eighteenth century; it has been explicitly recognized by governments and international commissions, for example the International Commission on Radiological Protection among organizations promoting worldwide safety standards (ICRP 1978; 1990,1991):

"Most decisions about human activities are based on an implicit form of balancing of costs and benefits leading to the conclusion that the conduct of a chosen activity is worth while. Less generally, it is also recognized that the conduct of the chosen practice should be adjusted to maximize the benefit to the individual or the society ...

... no practice shall be adopted unless its introduction produces a positive net benefit to the group. (ICRP 1978)."

The commission clearly acknowledges the point that the benefits and detriments may not always be received by the same members of the population and thus, the issue of distributional equity must be dealt with. Distributional equity imposes some important limitations and this constraint was discussed, from a philosophical perspective, in section 2.4 and is discussed further in section 3.1.2 below.

Two important points can be made here. First, in the balancing of costs and benefits, *all* the benefits accruing to society are to be included, and not just those that will be received by particular groups or individuals to the neglect of others. And second, costs are to be considered as comprising the sum total of all negative aspects of an operation, including monetary costs and any damage to human health or the environment.

Figure 1 shows a conceptual framework. The notion of balance and the fact that risks and benefits are associated with all choices is recognized. Safety of a technology must not be viewed in isolation but it must be judged and assessed taking into account the economy-wide implications of the technology. The total life cycle risk associated with an option must be evaluated. The economy-wide benefits, through wealth creation, associated with the option, must also be evaluated. These when measured as the corresponding gains in life expectancy (GLE) and losses in life expectancy (LLE) provides a common metric, and a consistent basis for balancing the risks and benefits on the same scale.

Efforts to reduce relatively small risks in one area or favouring selected alternatives for attention, may result in a disproportionate loss of overall benefit. The remedy is to bring to light all the important consequences, direct and indirect, of any particular course of action, and to make an even-handed comparison of all the important benefits and detriments.

The total human effort available in a given society is limited by the health and willingness to work of its members. It follows that, ultimately, the total benefit which a society can produce for itself is proportional to the efficiency or productivity with which human effort and resources are used. Since all human activities have various associated elements of detrimental impact as well as benefits, it is the net overall impact that must be considered. In order that the net benefit can be assessed, all beneficial and detrimental elements of impact must be reduced to a common quantitative basis of measurement.

Inevitably the various beneficial and detrimental elements of impact of any activity do not fall equally on all members of a society. A minority of members may suffer a net detriment from an activity which benefits a majority. This gives rise to an important dilemma: Is it justified to impose a large risk on some particular individuals or groups in order to achieve even a great benefit for the public as a whole?

This dilemma is resolved by the capability of society to compensate affected individuals. The solution to the problem of defining what is meant by "net benefit" to society was provided by the Kaldor-Hicks compensation principle which states that a policy is to be judged socially beneficial if the gainers receive enough benefits that they can compensate the losers fully and still have some net gain left over. If the losers are in fact compensated fully, they are by definition transformed into non-losers and the policy is Pareto optimal. The measures may include protective barriers, compensation in kind or in money, or removal - the choice of the affected member being given primary weight. The measures needed to protect individuals from large detriments can be regarded as part of the cost of the project or activity.

3.1.1 Net Benefit

Given that knowledge is never complete and decisions must nevertheless be made on behalf of the public, the primary function of risk management becomes an activity that explicitly confronts uncertainty. A guide under such circumstances is to pursue a course of action that maximizes life expectancy, with due consideration given to health and quality of living.

The central difficulty in regulation is to ascertain how the concept of public interest is to be interpreted in a given situation. There are two particular difficulties encountered in the practical regulation of health and safety matters in the public interest. They are the two components of risk: the uncertainty, which is best described by probability, and the value or magnitude of the adverse effect ("harmful consequence").

Some hold that diverse benefits are strictly incommensurate, denying that benefits can be meaningfully compared. Such people refuse to be governed by preconceived rules on how to make rational decisions in these contexts; they reserve the right, presumably, to make decisions unfettered by rationale. We must emphasize that, however the individual arrives at his or her life decisions, what matters for public policy is the individual's preference itself. Such measures are justified, only if, and because, they create improvements in individuals' lives as seen by those individuals. An activity constitutes a net benefit to the public if it results in a net increase in life expectancy (the quality adjustment to be included if data are available and such refinement suits the purpose at hand). It constitutes a net benefit to a given individual if her share in the benefit is worth her share in the cost.

Spending resources to tackle the important and the obvious risks first is a rule that most risk managers seem to have forgotten. That "wealth is health is safety" is a point that needs to be acknowledged in the determination of the net benefit to society. There is emerging a broad consensus which points to economic status (or income levels) as the key determinant of overall health status and social well-being. Thus it is reasonable to expect all members to accept *small* detriments within the general range of variation of individual benefits and detriments in the society, in order that the society as a whole may benefit, and thus ultimately that individual himself or herself.

We also note that being a member of a wealthy society is, in itself, an important benefit because the overall wealth of the society allows the development of robust institutions capable of helping the hurt and the needy. The rapid improvement in the quality of life in human societies since pre-industrial times in the field of health and safety has been accomplished largely by the wise use of resources supported by advances in scientific and engineering practices.

3.1.2 Constraints on the Imposition of Risks

The distributional aspects of detriments and benefits are important issues that must be reconciled with the broader objective of maximizing the total net benefit to society. There are two major concerns here.

First, there could be options that maximize this net benefit but should be excluded by considerations of human rights (for example, projects that with near certainty will kill or hurt identified individuals - the "human guinea pig" argument). This imposes a limitation that is easily identified in practice for the class of undertakings considered here, notwithstanding that general

resolution of the conflict between the interests of the individual and the collective is philosophically difficult.

Second, and in practice more serious, is the fact that neither risks nor benefits in terms of safety are always distributed uniformly within the group. At one level, this is a completely general problem; all benefits and all detriments are unequally distributed. At any given time, an average, either in terms of quality of life or a level of safety, can be discerned and assessed for a group, but every individual in the group deviates to some degree from these averages. In the case of setting a safety policy for the group, the statistical nature of the benefit and the detriment plays an important role because the individual gainers and losers cannot be determined a priori (the *"slings and arrows of outrageous fortune"* continue to whizz by). If the policy enhances the overall well-being of the group, then the individual will probably benefit in a general way as a member of the group. However, in application of the policy to the case *where an individual can be identified beforehand* as being one who loses as a result of a project or an undertaking, established procedures for *compensation* must be followed or new procedures negotiated.

Hence, the intent of the proposed safety objective is maximization of the total net benefit in terms of quality adjusted life expectancy for the entire group affected, but with this important proviso: *maximization of the benefit to the group must not be at the expense of identifiable individual(s)*.

In practice, to be sure, even some identified individuals may sometimes be known to be unusually likely to lose from a given intervention. A practical approach under such circumstances is to reduce the detriment to a low level, and to eliminate any remaining inequity by compensation.

3.1.3 Treatment of Uncertainty

All activities, present and future, involve an element of uncertainty. Only the past can be certain. (And even for that case, our knowledge or information about the past is often uncertain.) In some classes of social and economic impact the uncertainty is major and of fundamental importance. Risk to human life because of unintended or unanticipated failures in an activity is an important example. Recognizing that the available information is never complete, we have little choice but to do our best. The most probable, and not any assumed extreme, outcome must be the main basis for appraisal of the future. This is why the phrase *"greatest net benefit"* must always be qualified by the word *expected*.

It often happens that the data on which to base the numerical probabilities that go into an estimate of risk are inadequate. The uncertainty is then salient, and the cautious may be tempted to declare that the probabilities are a useless basis for decision. This, too, is often used as a strategy to move a decision into the political realm, where the chances of influencing it may be greater.

This tendency to refer the resolution of an issue to the political process is tempting but not helpful. Spurious accuracy in numbers is not misleading to those who are aware of its presence, as the critical administrator or decision-maker ought to be. Decisions based on unquantified uncertainty are open to arbitrariness, and are difficult to document and give account for. *Every decision involves uncertainty*. Selecting the probabilities on which to base a decision is part of the decision problem, and often it is the most important one.

3.2 PRINCIPLE #2

The safety benefit to be promoted is life expectancy.

The goal is to ensure that all risk mitigation efforts maximize the net benefit to society in terms of the length of life for all members at all ages. This can be further adjusted to include health expectancy and other factors that affect the quality of life, generally referred to as the quality adjusted life expectancy (QALE). Figure 2 shows qualitatively the relationship between cost and levels of risk. Risk level is proportional to the expectation of life; a high level of risk implies a high level of mortality and other ill-health effects in a population. The level of risk (shown on the ordinate scale) can always be reduced from a high level to a low level resulting in a gain in life expectancy (GLE).

The total societal cost of risk reduction (as shown on the abscissa in Figure 2) includes all direct and indirect monetary costs and these must be reflected in the loss in life expectancy (LLE). The losses in life expectancy (LLE) can be attributed directly to lack of risk control or indirectly to inappropriate safety measures. Losses in life expectancy also arise indirectly from a loss in real disposable income. The gains in life expectancy (GLE) occur directly from risk reduction efforts or indirectly from increase in wealth. Thus, the trade-offs are in terms of life expectancy gained versus life expectancy lost. The safety objective must explicitly account for expenditure of human effort and it must be demonstrated that the net benefit to society in terms of human lives is positive. If the GLE being greater than the LLE criterion is not met in Risk Management practices, then we are needlessly throwing resources and lives away.

Social indicators and assessment of incremental changes provide a quantitative measure for testing the rationales and effectiveness of public decision-making. The Human Development Index (UNDP 1990) promoted by the United Nations Development Programme and the Life Product Index (Lind et al 1991a) are two aggregate social indicators that relate to a quality-adjusted life expectancy. We propose the use of social indicators to provide a quantitative measure for assessing effectiveness of public decision-making (discussed further in Section 3.2).

The basic rationale for the use of a social indicator such as life expectancy is derived from a consideration of the variables important in describing the process of human development. Human development is about enlarging people's choices. At all levels of development, the three essential considerations are for people to lead a long and healthy life, to have access to resources for a decent standard of living and the knowledge for necessary cultural enrichment. If these essential choices are not available, the rest is academic. Use of life expectancy as a principal indicator of human development rests on three considerations: the intrinsic value of longevity, its value in helping people pursue various goals and its association with other characteristics such as good health and nutrition.

Preston and Keyfitz (1972), who have made important contributions to our understanding of social demography and causes of death state:

> "The circumstances under which men die are closely related to the conditions under which they live. The extent of violence, poverty, and ignorance in a population is reflected in the statistics of its causes and ages of death. Vigorous attempts to delay death are so universal that accurate mortality statistics provide a reliable touch-stone of a population's level of social organization and technological sophistica-tion. Not only do mortality conditions mirror those in the general society, but they also have their own important social implications."

Life expectancy is an appropriate measure of human safety. It aggregates the probability of survival of all age groups. It provides an effective indicator of the level and potential for improvements in human safety. This is a quantitative goal and scientific methods are applicable. When all costs and benefits, expected losses and harm are expressed in terms of length of life or life expectancy, then it becomes possible to develop a meaningful perspective with respect to the total burden of risks.

If safety management is to be directed to maximizing the quality-adjusted life years available to the public, then targets ought to be set and public account rendered for all major undertakings in a unified way. Furthermore, life expectancy is a widely available statistic and it is robust enough indicator that allows comparison of trends over time and among countries. It is also a concrete measurement that is meaningful in terms of individual experience.

It is a common observation that wealth is not the same thing as health or happiness. This, however, has also given rise to a common attitude that money is "only" money, and thus that in order to save a life, for instance, any amount of money is worth spending. *This attitude is mistaken.* The fact is that wealth makes for health and longevity, while lack of wealth makes for sickness and short life (Thompson, 1975; Kitigawa and Hauser, 1973; Hadley and Osei, 1982; Wilkins et al., 1989; Wilkins, 1986; Wilkins and Adams, 1983; and Wilkins, 1980). For this reason, it must be realized that large expenditures of money derived from taxation *cost life*, not just something abstract, money, that can be disdained. Though wealth is not specifically identical with health, it is so important an indicator of it that we can say that a society's ability to achieve improvements in the health status of the population is possible if and only if it has the wealth to do so.

A rational evaluation of any technology option, its attendant risks and provision of safety programs in the public interest requires that the impacts on life expectancy (including refinements such as the quality adjusted life expectancy in terms of health) and the real gross domestic product be evaluated. Figure 3 identifies the important components required for evaluating the net societal benefits in order that the criterion of acceptability for the health and safety objective can be met.

The search for a balance between the marginal costs of risk control and the value of risk reduction has proved elusive for good reasons. The attributes of risk are many: voluntary versus involuntary nature of exposure to the hazard, the degree of personal versus institutional control, familiarity versus the dread factor characterized by potentially large catastrophic consequences of a global nature. The perception of risk tends to be governed by psychological factors unique to each hazard. The number of key-players (namely, citizen groups, government officials, industry proponents for a project) and their primary objectives tend to be different. The principles proposed here would allow decisions to be made on the basis of comprehensive evaluations of alternatives in terms of clearly relevant measures of risk and benefit.

Ideally, with time, and through public discourse awareness of the general cost of extending the expectancy and quality of life (or whatever social indicator is used to express "value") will increase. This will provide the basis for informed debate and instruction to the professions in matters of safety. The necessary quantitative social indicators are available and sufficiently developed for decision-making in matters of public safety, despite the fact that uncertainties and subjectivity of values will always be present.

3.3 PRINCIPLE # 3

Decisions for the public in regard to health and safety must be open and apply across the complete range of hazards to life and health.

A basis for enhancing the openness and accountability of the safety management process requires a dispassionate assessment of the options. For a rational resolution of risk management problems, we need:

> i) transparency of the decision-making process; the measure must satisfactorily address the health and safety concerns of the people through a process of consultation and consensus building; and
>
> ii) development of a single meaningful measure that can be applied universally and consistently in practical contexts.

This requirement for a unified rationale is admittedly strict, yet it is essential if we are to have a working basis for practical professional action in society's interest. It is not different from other public decision-making rationales. It is an imperative ethical requirement that there be a single, clear indication of the process for management of risks affecting the public. It could be viewed as the foundation of a professional ethics for public risk management, analogous to the Hippocratic oath. It reflects a view of risk in sharp contrast to the view that risk is not measurable, that it is subjective, that its acceptability cannot be established in any credible way for society as a whole, and that each management situation is different from any other.

This is in sharp contrast to the notion that the nature of risk is interminably disputable. Of course, decision-making is always a choice between alternatives and uncertainty is basic to the problem of risk management. But that should not be taken as reason for abandoning all hope when we get into such areas. On the contrary, it is the first duty of those who manage risks to see that lives are saved efficiently, not merely to create a perception of safety. This requires clear and solid reasoning, not nebulous waffling or arbitrary semantic dispute. And it is the second duty to inform the public of how safety and health are being managed rationally in the public interest. This requires a clear and precise understanding of what we are doing; otherwise, the public will be taken in rather than served.

Uncertainty is not incidental: it is the essence of the problem. A decision-maker who is a professional in the service of the public interest must deal with risk as a proper weighting of the possible outcomes by their probabilities, because only this will enable the decision-maker to achieve the greatest expected net benefit given the resources available for the purpose.

The complete range of outcomes (of a prospect, a policy, a process or a project) each with an associated probability, should be considered. An open account of risk is needed as a tool of applied science and public policy. The amount of uncertainty present may vary from situation to situation but this does not influence the decision process, it only influences specific outcomes.

The principles stated here are broad statements implying a preferred approach to management of health and safety concerns. For practical application, they will require elaboration, reservations and extensions, and a better definition of terminology. The process of trial and error and learning from experience has provided a sound basis for human activities and, as the first step, it is suggested that this pragmatic approach be accepted as valid and fundamental.

Further research and critical analysis will be necessary to support the intent of the principles when trial and error may be inadequate.

4.0 CONCLUSIONS

(i) Policies in the management of risks must maximize the net benefit to society subject to considerations of distributional justice and fairness.

(ii) A measure of human safety necessary to implement this principle is life expectancy. The tangible, measurable objective is to *maximize the length of healthy life for all members at all ages*. Such an objective is widely applicable and is not necessarily confined to the evaluation of any one technology option. The objective can be translated into a statement of the public interest and it will be possible to provide useful guidance to the decision-makers.

(iii) All the important consequences must be assessed consistently in terms of a common objective. Decisions in regard to risk levels for the public, if they are to be defensible and self-consistent, require an integrated system of assessments that covers the entire range of hazards under public regulation.

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Figure 1: Conceptual Framework For Managing Risk

Figure 2: Illustrating a Global Risk Management Objective and Diminishing Efficiency of Risk Reduction

Figure 3: Assessment of Net Social Benefits