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A BIOETHICAL PERSPECTIVE ON ACCEPTABLE-RISK CRITERIA FOR NUCLEAR-WASTE MANAGEMENT

M. N. Maxey

July 15, 1977

MASTER

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**A BIOETHICAL PERSPECTIVE ON ACCEPTABLE-RISK
CRITERIA FOR NUCLEAR-WASTE MANAGEMENT**

M. N. Maxey, University of Detroit;
prepared under consultant agreement with Lawrence Livermore Laboratory
for work sponsored by the U.S. Nuclear Regulatory Commission

MS date: July 15, 1977

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Foreword

The U.S. Nuclear Regulatory Commission has contracted Lawrence Livermore Laboratory to provide "Technical Support in the Development of Nuclear-Waste Management Criteria." Part of this effort involves development of acceptable-risk criteria for nuclear-waste-management operations. Such operations inevitably involve some risk to man and his environment. Indeed, no industrial operation can be devoid of all risk. The object, therefore, must be to determine an acceptable level of risk that can serve as a guideline for operational design and analysis.

Nuclear-waste management is a serious concern. Its hazards may be extremely severe. In addition, due to the extensive time required for radioactive decay of certain nuclides, it may leave a legacy of harm to future populations. Alvin Weinberg has characterized this latter situation as a "Faustian bargain," in which current generations reap the benefits of nuclear energy while leaving hazards for future generations to cope with.

Recognizing that such considerations transcend technological comprehension, we believe that a scholarly study of the moral and ethical

implications might contribute to our understanding of the problem. Such studies might best be performed by those with professional expertise in these areas of inquiry.

With this objective, Dr. Margaret Maxey was requested to perform this study. Dr. Maxey is Associate Professor of Bioethics at the University of Detroit. She has served as an ethical consultant on "The Plutonium Economy" to the National Council of Churches and has served on the Board of Directors of the National Center for Energy Education.

In conducting and reporting a study of this nature, it is extremely difficult, if not impossible, to avoid incorporating subjective material. This report attempts to present a moral and ethical perspective on nuclear-waste-management hazards and to encourage further academic inquiry into questions related to societal acceptance or rejection of technological risk. An understanding and possible resolution of these questions would greatly assist the technical community in dealing with such issues.

Jerry J. Cohen
Waste Management Program
Lawrence Livermore Laboratory

SPECIFICATIONS FOR ENDEVCO ACCELEROMETER

MODEL NO. 2262C-25 (range ± 25 g)

Dynamic

Rated range	-25 to +25 g
Useful range	-50 to +50 g
Overrange limiting	± 60 to ± 150 g
Sensitivity (at 10.00 V dc)	10 mV/g, nominal
Mounted natural frequency	2500 Hz, nominal
Frequency response	$\pm 5\%$, 0 to 750 Hz at 75°F (24°C); -35%/+10%, nominal at 0°F/200°F and 750 Hz.
Damping ratio	0.7 nominal at 75°F
Transverse sensitivity	3% maximum
Linearity and hysteresis	$\pm 1\%$ of reading, maximum, to ± 25 g; $\pm 3\%$ of reading, nominal, to ± 50 g.
Thermal sensitivity shift	-4%/0/-9%, nominal, at 0°/75°/200°F

Electrical

Excitation	10.00 V dc
Input resistance (at 75°F)	1000 Ω , nominal
Output resistance (at 75°F)	1000 Ω , nominal
Zero measurand output	± 25 mV maximum at 10.00 V and 75°F
Thermal zero shift	± 15 mV, maximum at 0°F and +200°F, reference 75°F
Insulation resistance	100 M Ω , minimum

Physical

Weight	28 g, nominal, plus cable at 6 g/ft
Material	Stainless steel
Sensing elements	Piezite Type P-11
Mounting	Tapped hole for 10-32 $\times$ 1/8" stud Recommended mounting torque: 18 in.-lb
Electrical connection	Integral 6-pin connector

A BIOETHICAL PERSPECTIVE ON ACCEPTABLE-RISK CRITERIA FOR NUCLEAR-WASTE MANAGEMENT

Abstract

Wisely managing the profound human and environmental risks of nuclear wastes requires complex moral and ethical judgments. Whereas traditional ethics is limited to interpersonal relations, a new system of ethics--bioethics--concerns man's relation with nature.

Environmentalists claim that technology has upset the balance of nature, that nature is sacred and has inviolable rights, and that man must therefore regulate his behavior to conform to earth's limited carrying capacity. They also say that Judeo-Christian monotheism and anthropocentrism have sanctioned the exploitation of nature in the West, whereas Eastern religions teach adaptation to nature.

Evidence suggests, however, that the balance of nature is neither absolute nor precarious, but is continually changing. Moreover, technology has brought more good than harm to man, and man's needs should supersede nature's. Other evidence indicates that the earth's resources may be neither limited nor nearly exhausted. Persuasive arguments also demonstrate that man's relation with nature is not traceable to religious assumptions.

In assessing the risks/benefits of nuclear-waste management, we should avoid risks that jeopardize the rights of future generations without imposing excessive sacrifices on the present generation.

Introduction

Criteria for acceptable societal risks associated with managing radioactive wastes will become increasingly clear as these criteria reflect an exhaustive formal method that exhibits:

- carefully measured or modelled risks compared against "reference acceptable risk levels,"

- positive systematic control of risks,
- public confidence that responsible institutions can and will improve safety (i.e., diminish risks).¹

Confidence in this expectation appears to be grounded in a certain

kind of faith, appropriately identified as a "managerial faith." The success of advanced technology in the modern world attests to the remarkable success of this faith. It has gravitated around the notion that "the most important things about life are ultimately manageable"; by extending the division of labor, seemingly intractable problems can be reduced to manageable proportions with the result that "men are thus empowered to deal with their condition."² The pragmatic success of a managerial faith contrasts sharply, however, with that of theologians of other faiths, who have believed that such matters were ineffable, unalterable, and beyond human powers to divine, much less control.

Despite an undeniable success, the record of historical experience amply attests that the human spirit is restlessly at odds with a managerial faith. On the one hand, it is altogether understandable that management and long-term planning required by advanced technologies should ceaselessly generate the urge to establish a predictable routine and to extend ever-wider control over uncertain consequences in a more total environment to make plans come true. On the other hand, it is likewise understandable that a human thirst for spontaneity and innovation, for creativity and adventure, should

ceaselessly find ways to disrupt the routines and alter the planning.

A misinterpretation of the conflict might lead a technologist to conclude that risk-taking is inimical to the human spirit. Nothing could be further from the truth. Life without spontaneity, adventure, and risk--life totally managed, controlled, and predictable--is devoid of human interest or attraction. Criteria for the acceptability of risk should include a more comprehensive perspective on our common human condition, seen as a point of departure from the past and as a set of real possibilities for the future.

In the interest of bringing some clarity to that perspective, this study proposes to examine our common human condition as it relates to acceptable-risk criteria by exploring answers to three general questions:

- (1) What basic ethical issues are raised by the values mankind has expressed through past technological developments in general, and present nuclear technology in particular?
- (2) What historical influence have major religious perspectives exerted on assumptions underlying our current anti-technology, environmental-crisis mentality?

- (3) What is our general obligation to future generations, and how does it relate to the

acceptability of risks associated with nuclear fuel and radioactive waste?

Technology, Environment, and Human Values: The Ethical Issues

In an insightful essay, "Ethics of Technology," Professor George Pickering suggests that the way to avoid the invidious distinction between facts and values is to define values very simply as "those goods which depend for their fulfillment on human activity." And, he says, if we wish to extricate ourselves from a world in which "the dignity of human action seems to be demeaned because invention has incestuously become the mother of necessity," we must begin to understand technology "not only as a highly integrated set of values but also as the single most powerful set of values entering into the constitution of the modern world."²

The fact that technology has become a questionable activity in our century does not imply that the question has been meaningfully formulated. It only implies that the issues raised by technology are not merely or primarily technical problems; they are social, political, ethical, and, in the opinion of some, moral.

The difficulty about defining technology-induced issues is typified

by a recent statement about public ethics: when someone announces that the public needs to define and consider "the ethical and moral issues," the phrase usually "heralds the frustrated end of a discussion, or the beginning of a muddled argument."³ This remark underscores the fundamental problem. It has never been more evident than in the way one alternative energy source--uranium--has become targeted for elimination by certain environmentalists and political activists. In various public forums, they have argued that this energy source raises key issues which are not scientific or technical or economic, but moral and ethical. They go on to allege that experts in the nuclear energy field are professionally unqualified for making ethical or moral judgments, because they can only make technical assessments and economic cost-benefit analyses. The inference is that only persons who are scientifically illiterate and technically ill-informed can be trusted to raise moral and ethical issues for public

debate. Presumably, science and technology are corrupting influences on the purity of moral judgments.

Raising issues in accord with such reasoning is problematic for at least three reasons: confusion between the terms morals and ethics, disagreement about the definition of the human good, and differences between long-range goals and pressing social problems.

MORAL ISSUES VS ETHICAL ISSUES

The terms ethics and morals designate very different perspectives on human behavior.⁴ In philosophical literature, the word moral has two meanings: (1) the human capacity to make value judgments, and (2) human behavior consistent with ethical standards. According to the first usage, moral means the opposite of nonmoral, unmoral, or amoral, which denote a person who is unable to judge something to be right or good (an insane person). In the second usage, moral means the opposite of immoral, which denotes someone whose behavior is wrong or evil when judged by some accepted standard.

By contrast, ethics is generally regarded as a systematic philosophical analysis of moral value judgments and choices; it consists of theoretical, or rational interpretation of moral activity, whether individual or social. Normative ethics not only

investigates moral theories, but also tries to establish criteria and principles that enjoin moral persons to adopt or refrain from certain judgments and conduct.

Moral judgments and ethical judgments about a disputed policy or pattern of behavior are neither in practice nor in theory identical or interchangeable. Rather, these terms designate two distinct levels of discourse.⁵

At the moral level, people operate within value codes derived from their social, religious, or ideological commitments. The function of these codes is to prescribe what one ought to do in particular cases. Customarily, people simply apply (in slide-rule fashion) unexamined rules to specific problems of conduct or decision. But when conflicting values or circumstances lead one to ask whether a moral rule prescribing an action is really right, "the effect of such a question is to throw doubt upon the validity of the rules themselves."⁵ The recognition of alternatives to an action leads to a fundamental reconsideration of an entire code. As a result, one is compelled to move to the ethical level of discourse.

At the ethical level, we re-examine uncritically accepted moral values, priorities, and prejudices. At this level, we are dealing with principles

for maintaining reasonableness, for appraising value systems, for justifying methods of decision-making, for balancing conflicts of interest. Personal moral judgments must be put to the test of justification at this more comprehensive level of consideration. At a post-ethical level of discourse, the problem becomes discovering the purpose of being moral at all and/or the ultimate meaning system which one should use to justify proposed ethical criteria.

At both levels, the ethical issues raised are quite different from those raised by an unreflective moralist. As a definable characteristic, moralism is a deficiency that results from the persistent failure to recognize an ethical justification that is acceptable and undertakes responsibility for harmful social consequences of private moral judgments, however well-intentioned they may be.

NEIGHBOR ETHICS VS TOTAL-SYSTEM ETHICS (BIOETHICS)

A second problem of raising issues is the confusion and disagreement over two different conceptions of how ethics should define the human good. According to Professor Hans Jonas, traditional ethics has assumed that the consequences of human action--hence human responsibility--are confined to the here and now, to known

and intended effects. Therefore, it has defined the human good as a moral imperative expressed in "neighbor values"--justice, truth-telling, freedom, respect for individual human rights, etc.⁶ This constellation of values is reflected in the current effort of government leaders to draw up ethical codes of behavior for public officials, as well as for private citizens. So conceived, ethics is anthropocentric, with the non-human world of nature a neutral backdrop.

But science, technology, and a population explosion have drastically changed the causal scale of human activities, as well as our integration within nature's complex, delicate web. As a consequence, traditional neighbor ethics has become increasingly problematic, because it is too shortsighted and piecemeal in its definition of issues, goals, and human responsibility. Albert Schweitzer is often quoted in this regard: "The great fault of all ethics hitherto has been that they believed themselves to have to deal only with the relations of man to man."⁷ Because of the awesome range and power with which human actions may affect the global environment for generations, a traditional neighbor ethic is simply inadequate to define criteria for the human good.

Jonas urges us to realize the need for a new concept of ethics commensurate with the new scope of human action. He says that we must plan much further ahead with a "total-system" ethics shaped by a new set of imperatives. For example: "Act so that the effects of your action are compatible with the permanence of genuine human life." Or again, "In your present choices, include the future wholeness of human persons among the objects of your decisions."⁶ These imperatives presuppose an ability to acquire and disseminate an unprecedented degree of knowledge. A new total-system bioethics will raise issues from a perspective quite different from that of a traditional neighbor ethics. (For a discussion of total-system bioethics, see the appendix.)

SOCIAL ETHICS VS PUBLIC ETHICS

Recognizing the need for a new concept and system of ethics is not enough. Changes in the scale of human action require not only a new genus of ethics, but also a new subspecies -- "public ethics."³ Conventional social ethics deals with the good or right ordering of human communities, and with shaping long-term changes in social policies. By contrast, public ethics must meet a different set of exigencies:

- It must deal with a precise problem requiring a particular public decision.
- This problem is pressing; it must be resolved soon.
- The decision to be made is neither intended nor expected to change the social order profoundly.

Current practitioners of public ethics have set three tasks for themselves. First, they propose to articulate the conflicting values that underlie a public concern, to transform them into an ethical argument that clarifies what can or cannot be justified. Second, they try to identify policy options, and then defend or criticize them by appealing to justifying reasons. Finally, they rank these policy alternatives in some order of ethically preferable choices.

Ranking policy alternatives necessarily involves assessing risks vs benefits, weighing social and economic costs vs benefits, balancing a hypothetical vs a verifiable erosion of the quality of life. *Far from being merely crass utilitarian tradeoffs, these exercises in human judgment are a necessity for responsible ethical decision-making.*

Because it links ethics and politics, public ethics cannot indulge

in the luxury of rarefied abstractions. To the extent that politics is "the art of the possible," public ethics endeavors to practice "the art of discerning the morally preferable among the practical possibilities."⁸

From this review, it becomes easier to understand why the alleged moral and ethical issues raised by nuclear technology cause heated debate, if not muddled confusion, in the public mind. It remains to be seen how these conflicting terms relate to conflicting assessments of technology and its effect on the environment.

ETHICAL ISSUES RAISED BY ENVIRONMENTALIST ASSESSMENTS OF TECHNOLOGY

Some social historians regard the publication of *The Silent Spring* in 1962⁹ as a turning point in precipitating what is popularly called the environmental crisis. Even a cursory reading of the environmentalist literature since then demonstrates that many persons hold the misconception that modern technology is alien to some pristine human condition. They refuse to consider seriously the evidence that mankind has from the beginning of recorded history developed an organic relationship with technology. It is an imitation and extension of our own biological form and function,¹⁰ dependent for its

being and fulfillment on human activity,² and even a sacrament of liberation from mindless, subhuman drudgery and an opportunity for psychosocial development and maturity.¹¹

We cannot know, observes Pickering, whether those we call primitive men regarded their drive toward technological development as a liberation from, or a fulfillment of, their inherited modes of existence. But we do know that the fundamental driving force throughout human history has been "a refusal to be dominated by the rest of nature." In our own decade of controversy, human beings have continued their dispute over what form that great refusal ought to take:

"... whether the domination of men by the rest of nature should be broken by magic, by religion, by art and craft, or by science and technology; . . . by discerning the rhythms of nature in order to oppose them or adopt them or manipulate them; by adopting the stance of participation of transcendence or exploitation."²

Paradoxically, our current technological development has become the most unifying yet the most divisive force in our common humanity.

At least since Earth Day 1970, we have been inundated with allegedly hard evidence that the deterioration of the human species and our natural environment is accelerating at an exponential rate,¹² and that our

only habitable planet has been raped and polluted by technological man, recklessly driven by rugged individualism and selfish greed. The damage inflicted has been portrayed as approaching eco-catastrophe.

Rivers and streams have allegedly been turned into sewers: Lake Erie is dead and Lake Michigan is fast dying. Environmentalists tell us that species of birds and animals are becoming extinct at a rapidly increasing rate: the last dodo died in 1689, with hundreds of other species dying since. According to Paul Ehrlich and Garrett Hardin, our insecticides and weed poisons may have increased food supplies for an exponentially-increasing population, but these toxic chemicals appear to have found their way up the food chain to enter and poison ourselves. The green revolution in underdeveloped countries seems to have had disastrous unforeseen consequences: soil depletion, followed by erosion and floods, not to mention the sustaining influence on the upward spiral of an already vast and starving population. More people to feed, clothe, and shelter means a greater consumption of energy and an eventual exhaustion of nonrenewable resources, as well as more pollution of the earth's atmosphere, soil, and water.¹³

Technological interventions, pretending to be solutions, are

indicted for being not only insufficient but downright dangerous: advanced technology applied to agriculture, industry, energy-conversion, and medicine has generated the environmental crisis in the first place. Our high-technology society is accused of having done more than any other to release toxic chemicals and radiation sources into our environment. Some environmentalists claim that even the ozone shield is becoming depleted. Allegedly, radioactive carcinogens have made preparation of food a lethal operation. Expert environmentalists testify in congressional hearings that even mother's milk is poisoned. The world has become dismally unsafe.¹⁴

In the name of sheer survival, we are further warned that rising human expectations demanded by more and more people simply cannot be met by accelerating the rate of technological solutions. Growth of everything--above all, high technology--must come to a halt. According to David Brower, one of the root causes of the environmental crisis is a "growth ethic" that does not lead to increased well-being for the majority of people, but rather leads to increased oppression and alienation of the many, while the few get richer and suffer from bad consciences.¹⁵ We are told that our goal must be a steady-state society, an ecostasis, a sustainable

environmental quality. In short, for anyone except the blind and the immoral, an ecological crisis is simply self-evident. The short- and long-term solutions are a matter of simply making the right anti-technological choices immediately. The strategies are clearly dictated by our sense of moral obligation.

Having at last achieved an ecological crisis-consciousness, environmentalists have come of age. Other affluent Americans must be made to realize that our materialistic consumerism and careless technology reflect the values of a spoiled child. The adventuresome spirit of exploration with its new frontiers to conquer, its exultation in the vitality of growth, is at best adolescent. Fortunately for us all, that ultimate symbol of devotion to technological mastery--the space program--signed its own death warrant when electronic wizardry transmitted back to earth a sobering vision of our isolated, finite, fragile planet. Our only reliable spaceship now is earth: a small, sick planet that we--her only friends--are morally obligated to heal and preserve for future generations.

So much for crisis-consciousness. Only by comprehending the climate of crisis generated by the ecology movement--its historical pedigree and underlying assumptions--can we expect

to understand the reason why certain technological risks are dismissed as unacceptable.

THEMES AND ASSUMPTIONS UNDERLYING ENVIRONMENTALIST ISSUES

Environmental literature varies greatly, of course, in style and substantive content. When stripped of its rhetoric, however, the following themes and underlying assumptions recur.

(1) The first and most fundamental is that some vague, fragile "balance of nature" has been upset, if not irreversibly destroyed, by man's mindless drive toward mastery over nature by means of an ever-developing, encroaching technology.¹⁶

(2) Closely connected with this notion of a balance of nature is a quasi-religious assumption that nature is in itself, or by derivation from a deity, sacred. The implication is that nature is not only unspoiled or pure in its pristine, wilderness condition, but also endowed with certain inalienable rights which for man to violate or transgress would be immoral.¹⁷ Human needs, consequently, should be stringently regulated and our social institutions restructured so that individual life-styles and reproductive choices can be predetermined not to exceed prescribed, quantifiable limits.

(3) Moreover, the quality of life must cease to be a moving target, freely defined by individuals or elitists, and must now be made the dependent variable of earth's limited carrying capacity.

The cultural climate of crisis generated by the leaders and literature in the ecology movement, its historical pedigree and underlying assumptions about nature, man, and earth's limited carrying capacity naturally leads to the quasi-religious fervor and moral indignation which motivates much of the political opposition to nuclear technology and radioactive wastes. Arguments pro and con about radiation hazards from the fuel cycle, reactor safety, terrorist blackmail, and weapons proliferation are secondary to the fountainhead of the entire controversy.

That is to say, a number of persons in our democratic society have

made dramatically different value judgments about what constitutes a good society. Nuclear scientists and engineers often contend that this energy-conversion technology has, at an excessive price, been made demonstrably safe and ecologically preferable to fossil combustion. But that assurance, says Irwin Bupp, is irrelevant. "The nuclear critic merely responds that he objects to the type of social environment that engineering or administrative 'success' implies."⁸

If public opposition to the acceptability of risks from nuclear technology and radioactive wastes is to be adequately understood, then the historical and religious roots from which ecological assumptions derive their momentum must be understood, as well as current challenges to the prevailing crisis-consciousness.

Ecology Themes and Assumptions: Historical Roots and Religious Influences

A considerable body of literature derives from Lynn White's essay, "The Historical Roots of Our Ecologic Crisis."¹⁸ It is generally regarded as the most influential article stimulating religious/theological reflection on the man-technology-environment interrelation. His thesis is that the root cause of our

desecration of nature and subsequent ecological crisis in the Western World must be traced to the Judeo-Christian ethic. A number of theologians, conservationists, ecologists, and economists appear to have accepted this provocative thesis as an article of faith.

Fundamental to that thesis is the assumption that religion and philosophy have direct ecological consequences, because what men think about nature greatly affects the way they act toward nature. White's objective in trying to show the direct connection between religious doctrines and the present ecological crisis is to propose an alternative Christian mindset. Briefly stated, his argument takes this form. Whereas animistic, pantheistic, and polytheistic religions of ancient and Eastern civilizations have inhibited man's technological domination over nature (because it was believed to be inhabited by deities or was itself divine), the radical monotheism of Western Judaism and Christianity has, in effect, desacralized nature, robbing it of divinity and thus destroying taboos against man's appropriation of nature for his own purposes.

Two Judeo-Christian doctrines that have been the most consequential are a monotheistic God and an anthropocentric Creation. By emphasizing the dominion God has given man over nature, they have sanctioned an exploitative ethic.

"By destroying pagan animism, Christianity made it possible to exploit nature in a mood of indifference to the feelings of natural objects."

Professor White concludes, after lamenting modern man's "ecological destructiveness," that "Christianity bears a huge burden of guilt."¹⁸

RELIGIOUS DOCTRINES FOSTERING EXPLOITATION OF NATURE

White developed his thesis as a result of observing that Ceylonese Buddhists building a road would not disturb or destroy a nest of snakes, but waited patiently until the snakes had departed of their own accord. That experience led him to contrast the Buddhist attitude of reverence toward nature with the Western religious attitude of superiority and exploitation. The Judaic concept of creation that Christianity inherited has taught man that "no item in the physical creation had any purpose save to serve man's purposes."¹⁹

Of all religions, Christianity is the most anthropocentric. In absolute contrast to paganism, Hinduism, Buddhism, and Taoism (with the exception of Zoroastrianism), Christianity "not only established a dualism of man and nature but also insisted that it is God's will that man exploit nature for his proper ends."¹⁹

The source of this religious doctrine appears to be unambiguously stated in Genesis. Having created

man, male and female, in His own image, God said to them, "Be fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth" (Gen. 1:28). Ecological critics of Christian tradition insist that God's mandate for man's "dominion and subjugation" of nature must be displaced by Eastern religious beliefs and attitudes.

White is dubious, however, about our adopting the man-nature view of Eastern religions as an antidote and solution to our ecologic crisis. Instead, he proposes St. Francis of Assisi, exemplifying self-sacrifice, as the patron saint of ecologists.

A number of other Western humanists have expressed a bias toward Taoist and Buddhist traditions by extolling virtues inherent in the Oriental precepts of quiescence and an adaptive approach to nature--e.g., the ethical philosophy of ahimsa (i.e., non-injury as a lifestyle in thought, word, and deed)²⁰ and the concept of feng-shui, or geomancy, defined as "the art of adapting the residences of the living and the dead so as to cooperate and harmonize with the local currents of cosmic breath."²¹ Construction blends into the landscape; natural curves are preferred to straight lines.

Yi-Fu Tuan, in his essay "Discrepancies between Environmental Attitude and Behavior: Examples from Europe and China," subtly refutes White's thesis about the power of religious attitudes to control behavior. There is a wide discrepancy, he maintains, between the commonly accepted official line on Oriental religious attitudes toward the environment and actual practice. He reviews the historical record and shows that gigantic transformations of the natural environment in Oriental civilizations were far from adaptive or geomantic. He cites cases of massive deforestation and erosion, of rice terraces and walled cities, of large-scale engineering of marshes and rivers. As an example,

"By the Sung dynasty (A.D. 960-1279) the demand for wood and charcoal as both household and industrial fuel had reached a level such that the timber resources of the country could no longer meet it; the result was the increasing substitution of coal for wood and charcoal."²²

Other evidence also refutes White's thesis. Centuries before the advent of any Judeo-Christian doctrinal influences, Plato's *Critias* lamented the deforestation and overgrazing of Attica. Since primitive times, agricultural people everywhere--Egyptian, Assyrian, Roman, Persian, Indian, Aztec, Buddhist--have cleared

fields, dammed streams, killed predatory animals, as well as extirpated unwanted plant life.

Little historical evidence supports the contention that a Judeo-Christian ethic of exploitation has caused our alleged environmental crisis. Even less evidence indicates that a Taoist-Buddhist ecological ethic of nature can be summoned to replace it. In the view of Rene Dubos, White's theory that religious attitudes are responsible for a technologically-induced ecological crisis is "at best a historical half-truth." To the contrary,

"... erosion of the land, destruction of animal and plant species, excessive exploitation of natural resources, and ecological disasters are not peculiar to the Judeo-Christian tradition and to scientific technology. At all times, and all over the world, man's thoughtless interventions into nature have had a variety of disastrous consequences or at least have changed profoundly the complexion of nature."²³

RELIGIOUS DOCTRINES FOSTERING SCIENCE AND TECHNOLOGY

The second idea developed from White's thesis is that there is a demonstrable connection between the Judeo-Christian ethic of exploitation and the development of Western science and technology. The idea is not original with White. Other Christian theologians earlier maintained that

the connection between technological development and biblical faith is more than accidental. In 1954, Arend van Leeuwen extolled the gift of Christianity not only as a liberation from "the fetters of 'sacred' tradition," but also as "the renewal of society in the direction of a truly secular and man-made order of life."²⁴ In 1965, Harvey Cox credited both biblical faith and the theology of Karl Barth for having dismissed myth and ontology with the result that "man's freedom to master and shape, to create and explore now reaches out to the ends of the earth and beyond."²⁵ These statements were quite popular before environmentalism had dispatched technology into its current state of disrepute.

As a historian especially knowledgeable in medieval technology,²⁶ White shares the basic premise of these theologians, namely, that "the victory of Christianity over paganism was the greatest psychic revolution in the history of our culture." Indeed, our implicit faith in perpetual progress, unknown either to Greco-Roman antiquity or the Orient, cannot be understood apart from its roots in Judeo-Christian teleology; i.e., the divinely-intended purpose of all creation. The fact that Communists share it only confirms what is otherwise demonstrable: "that

Marxism, like Islam, is a Judeo-Christian heresy."¹⁸

Since the Creator has made nature and man in His own image, the religious study of nature (natural theology) can reveal the divine mentality. In fact, what motivated such scientists as Galileo, Leibnitz, and Newton in the past to decode nature's symbol system was "to think God's thoughts after Him."¹⁸

Unfortunately, with the marriage of science and technology a century ago, man acquired powers which have had such disastrous ecological effects that, says White, we now recognize them to be "out of control." Whether people think that their technological attitudes are Christian is irrelevant; their basic values have not been displaced. Consequently, "we shall continue to have a worsening ecologic crisis until we reject the Christian axiom that nature has no reason for existence save to serve man."¹⁷

Arnold Toynbee has given strong support to White's contention. Based on his observation of modern religion in Eastern Asia and his book-knowledge of ancient Greek and Roman religion, he avers that the spread of monotheism "has removed the age-old restraint that was once placed on man's greed by his awe." Even where monotheism has never been established, the

monotheistic disrespect for nature has survived.

"Japanese converts to Christianity have been few . . . but the Christian attitude to nature, which continues to be the post-Christian attitude, has prevailed in Japan in defiance of the contrary Weltanschauung that is implicit in the Japanese people's religions, Shinto and Buddhism."²⁷

Since the revolution of 1868, and more vehemently still since World War II, "the Japanese have been following the modern Western malpractice of exploiting nature, and they have been incurring the penalty."²⁸

Several writers have objected strongly to the White-Toynbee reductionism. Lewis Moncrief presents evidence that the Judeo-Christian tradition is only one of many cultural factors contributing to the alleged environmental crisis. He suggests that "the wide acceptance of such a simplistic explanation is at this point based more on fad than on fact."²⁸ To account for the alleged crisis as primarily "a religious problem" avoids several hard questions.²⁹ For example, why is it that science flourished so vigorously in China, in ancient Greece, or in medieval Islam without any influence from Christianity? Why did Christian doctrines of God and Creation in Eastern Orthodoxy not

produce the same science and technology developed by the Latin West? Since Christianity was dominant in the West from the fourth to the fourteenth century, how does White explain the collapse of Roman technology?

James Barr, from a detailed scrutiny of what the Old Testament might have to do with pollution of the environment, maintains that the doctrines and legends of the Jewish-Christian world in which science developed have obviously had an enormous influence upon it, along with everything else that went on. "But," he concludes, "to suppose that these doctrines not only influenced the rise of science but had an extremely vital and preponderating causal relation to it, seems just enormously improbable."³⁰

Thomas Derr puts the case succinctly: ". . . it would be careless indeed to run a direct line from Biblical thought to ecological disaster via disrespect for nature."³¹ For Montcrief, Barr, and Derr, the cultural influences that have operated to develop science and technology have not been single or simplistic, but instead multiple and diverse. In direct contradiction to White's thesis, evidence suggests that environmental follies have occurred no matter what mankind's religious preconceptions have been--and even where

sophisticated technology has not existed. In short, "to say that technological society is in a mess, and that therefore the fault must lie in the dominant religion, is to credit religion with too much power over culture and to forget how easily culture perverts religion."³¹

CHALLENGES TO ECOLOGY THEMES AND ASSUMPTIONS

Lynn White's essay and others since then have taken for granted that an environmental crisis exists and that scientifically generated technology is the causal villain. The case for a crisis cannot be made by appealing to any religious preconceptions as the root cause. According to key themes and assumptions of environmentalists, the crisis is self-evident. But a number of challenges lead us to believe that it is not.

Consider the first assumption. Among others, Gerald Feinberg and George Land have thoroughly discredited the concept of a balance of nature as it is commonly understood by environmentalists. When environmentalists claim that some human activity or technology has upset a presumed balance of nature and that dire consequences are about to unfold, they are assuming as a scientific fact that some vaguely intuited pre-established harmony of creation--some cosmic

Master Plan--has so arranged and fixed the components of nature within a certain unique condition that, if changed, a catastrophic immoral violation occurs.

To the contrary, says Feinberg, such an assertion strangely mingles fact with dubious moral judgment. "There are an infinite number of possible 'balances of nature' rather than a unique one."³² Because natural phenomena and living things exist in complex interrelations, changes in some components will result in adjustments made by others. When we human beings attach values to an older or to a newer set of natural conditions, and then judge one more or less desirable than the other, we do so because of the aesthetic or ethical priorities we have accepted. Rather than attesting to a scientific fact, we are instead making an aesthetic or moral value judgment. Certain environmental conditions, such as smog from auto emissions or ocean dumping of wastes, are undesirable not because they violate some sacred or unique balance of nature, but because we failed to think through the consequences or the alternatives before we created those conditions.

Feinberg offers this caution:

"I know of no case where anyone has made an even plausible argument that we are approaching an actual environmental disaster. I

think that in the absence of such a case, some environmentalists may, by their cries of doom, desensitize people sufficiently so that when a real crisis can be scientifically demonstrated, no one will be listening to them."³²

What criteria ought we to use in judging whether an environment is good for human beings? Feinberg observes that, when people begin to talk about their idea of a good environment, it usually equates with the one they grew up in or most enjoyed in childhood. Very little thought has been given to useful criteria for deciding whether any environment, on a global scale, is good for everyone. Instead, a small minority indignantly assert: large-scale technology, especially its energy applications, has been the cause of environmental degradation.

What does the historical record show? Have people suffered from advanced technology, or from the lack of it? Those who express a nostalgic wish to return to the simpler, purer life of a hundred years ago would profit from reading Otto Bettman's book, *The Good Old Days--They Were Terrible!*³³ As we condemn Detroit and auto emissions for making city air unbreathable, let us not forget a New York with 150,000 horses in the streets and the emissions they produced. Let us recall the accepted waste-management standards: kitchen

slops, coal soot, cinders, and other trash piled high on city sidewalks.

When the younger generation tells us that our rivers and lakes would be clean and potable if only they had not been befouled by profit-seeking corporate industrialism, they might re-read some pages from history. Past civilizations have handled human wastes with such primitive sewage practices that in many places water pollution was worse than it is today. During our entire existence on earth, the quantity of air pollution produced by mankind does not begin to equal the quantities of toxic gases and particulates spewed forth from just three volcanic eruptions: Krakatau in Indonesia in 1883, Mt. Katmai in Alaska in 1912, and Hekla in Iceland in 1947. Nature releases ten times more carbon monoxide into the atmosphere than all the activities of man.³⁴

When consumer advocates go through their litany of technology-induced hazards in the biosphere, citing in particular excessive radiation, pesticidal chemicals, or carcinogenic good additives, someone should restore a historical perspective to the mounting crescendos of fearful protest. Among others, William Lowrance reminds us of what a life without advanced technology applied to agriculture, medical care, and generating electricity was really like: spoiled

food, impure water, boiling laundry kettles, and the backyard lye pot. People were poisoned from unknown chemicals in many natural/organic vegetables. Women canned food with such preservatives as boric acid and formaldehyde in high concentrations. The major insecticide 75 years ago--sprayed on everything from apples to strawberries to grapes--was lead arsenate or "Paris green." Red food coloring was not red dye #2 but lead chromate--a horror to day's biochemist. Fatal diseases were not leukemia or Hodgkins disease or subtle forms of cancer. They were pneumonia, influenza, tuberculosis. Average life expectancy was forty to forty-five years at the turn of the century. More than 13% of all infants died before their first birthday. The leading antiseptic in homes and hospitals was corrosive carbolic acid. Today, as some worry about the disinfectant hexachlorophene in soap, why do they so easily forget the harsh carbolic acid it has replaced, and the surgical operations it has made safer?³⁵

Has our world become dismally unsafe because of science and technology? Have environmental hazards increased in fact, or only in our levels of perception? Lowrance puts the case well:

We now have the luxury to worry about the subtle hazards which at

one time, even if detected, would have been given only low priority beside the much greater hazards of the day.³⁵

Consider the second assumption.

When certain environmentalists express revulsion for humankind as the supreme pollution of the earth, they are thereby exposing an ethical value system whose social consequences could prove to be far more catastrophic for human welfare than any alleged environmental degradation.

It is one thing to become fully conscious of, and apply a remedy to, the mischief that has been wrought by misapplications of poor technology by shortsighted and greedy human beings. It is quite another to make the value judgment that, because of this mischief, the environment has rights that can take precedence over the rights of living human beings to satisfy basic needs. The ethical priorities of Joseph Meeker are typical of an extreme, yet not uncommonly shared view: people are replaceable; the giant redwood trees and endangered species are not. Professor Meeker objects to any discussion of resource allocation, or population and pollution control, as these serve to maximize human welfare, without discussing at the same time "the welfare of plants and animals . . . Other forms of life have equal rights to life with men." His value

system is transparent in this statement: "It is not important that individuals survive; but it is important that as many species as possible survive."³⁶

Thomas Derr flatly rejects this ethical priority system in stern words: "Here we have the ethical fruition of the idea of nature's 'rights' against human life. Here we have a root of the incredible callousness of some ecologists who hold much existing human life rather cheap." When this callousness is buttressed by prophets of environmental doom, the harm done to ethical sensibilities is great--the few are driven to assure their own survival at the expense of the many. "Symptoms of this moral disease," Derr continues, "are already present among ecologists who urge the powerful nations to look to their own interests and let the hungry masses starve, so that world population may be reduced to more acceptable levels." Those who set such a high priority on their standard for environmental quality that they would deliberately starve living persons today are indeed championing a "new set of ecological values" and an unjustifiable "ecological ethic."³⁷

The poor at home and abroad express profound resentment when ecological "realists" recommend a freeze on growth, anti-consumption, and self-denial. Social justice and protection

of the environment require a global policy that will undertake vigorous efforts to meet Third and Fourth World needs for energy resources. Otherwise the leaders of the poor will justifiably reject ecology as their enemy, and pursue their national development without any concern for possible damage to global environment.

Consider the third assumption. The twin concepts of natural resource exhaustion and a fixed carrying capacity have both been rendered questionable. Rene Dubos states the case against resource exhaustion tersely: "I would say that there are no natural resources in the world; all that we call 'natural resources' are raw materials transformed by man." He offers three examples. First, agricultural land exists only where it has been transformed by human effort; new food production technologies are now being developed which will amount to "agriculture without soil." Second, our selection of mineral resources demonstrates that "a resource is not what is here, but what can be used by man for a certain goal." Although aluminum has existed on earth since the beginning of time, "it did not become a resource until this century when a technique for chemical separation was developed." His third example, energy, traces the development of myriad natural sources for

energy-conversion. About the assumption that resources are limited and nearly exhausted, Dubos states flatly: "Resources are always invented."³⁸

The case against a fixed carrying capacity of the earth has been made by those who reject the "fixed pie" model of the world in favor of the "growing pie" model.³⁹ Until the living standard of poorer nations rises enough to satisfy their subsistence and security needs, the key to an ecologically sound planet, namely, a stable population level, will never be able to lock the door on an age-old enemy: wars over resources that could be used to improve standards of living and alleviate human misery. It is time we recognize the difference between undifferentiated growth for its own sake, and an organic development in which our ethical priorities are dictated by the basic needs of the world's poor for food, clothing, shelter, and a kind of security that does not depend on breeding more children than can be cared for. From historical experience with the Tennessee Valley Authority, we know how extensively electricity can improve basic living standards through refrigeration, medical health care facilities, sewage treatment, etc. Only electricity in reliable quantities can provide the minimum level of health and prosperity. In

the case of nuclear technology, we are not talking about growth but replacement. Enriched uranium and plutonium are proven resources for a demonstrably safe way of generating electricity.

Environmentalist priorities are not primarily, or necessarily, ethical priorities. Excessive concern for the environment has been defended

because of our obligation to future generations. From that view, radioactive wastes are characterized as a million-year risk that we are bequeathing to future generations in violation of our obligation to them. Consideration of the nature and scope of that obligation becomes highly pertinent to acceptable-risk criteria.

Obligations to Future Generations: Acceptable Risk Criteria for Nuclear Wastes

In one sense, our present decade is unique and unprecedented. Prior to the early 1970's, except for some abstract generalizations, there were virtually no systematic ethical reflection and published discussion about the nature and scope of obligations that those now living have to future generations.⁴⁰

Subsequent ethical discussions of responsibility to the future appear to have been evoked by, and restricted to, evaluations of biomedical research and potential technological applications, e.g., reproductive technologies (artificial insemination and in vitro fertilization), genetic engineering (algeny, cloning, positive eugenics), fetal research, recombinant DNA molecular technology, population control, etc.⁴¹ These discussions

are implicitly ethical assessments of risks and benefits. They address the problem of present generations reaping technological benefits that entail a legacy of risks or injury to future generations.

Risk/benefit assessment and cost-effective analysis are fairly recent.⁴² Their ascendancy seems to derive from the pragmatic success of that managerial faith referred to at the outset of this study. One major difference between this generation and all its predecessors is that our increased knowledge of cybernetics has enormously extended our ability to know predictively the range of consequences of human activity, to envisage their implications on a global scale, and to understand why certain activities have potentially global effects.

With all due respect to Malthus, this has not been the case in earlier generations.⁴³

Consequently, the concept of risks has been recently enlarged beyond those voluntarily accepted by individuals for occupational or personal benefits. Models for risk analysis have tended increasingly to predict, not present or local harmful events, but global catastrophes with a potential to affect future populations. A worst-case concept or an imaginary maximum credible accident seems unique to our present human condition. One ethicist regards the point of ethical departure from this condition as a simple fact:

"... we now have a human community of planetary proportions. 'Mankind' is no longer principally an abstract notion. Mankind is a vibrant complex reality. There are actual relationships binding men and places and activities to each other, spanning the globe; and this is a new thing in the twentieth century."²

Risk-assessment models express what is radically novel about our present ethical situation and heightened sense of personal moral responsibility.

"For the first time in history, we have to live in a world entirely encompassed by human powers. This does not mean that the individual human being feels more powerful in himself. Far from it. But what he is surrounded by are other human powers, not tigers and not gods."²

In our new ethical situation, our legacy to future generations has assumed a critical importance.

ETHICAL PRINCIPLES PERTINENT TO THE LEGACY-OF-RISK QUESTION

Martin Golding and Daniel Callahan have taken up the general question of obligations to future generations under three headings: (1) the nature and basis of that obligation; (2) how to balance obligations to future generations against obligations to an existing generation; (3) ethical norms appropriate for any present decision having implications for the lives of future individuals and groups.⁴⁴

It is not an idle question to ask how we can possibly have obligations to those who do not even exist--those with whom we will not share a common life or the same social ideal or a similar conception of the good life. Callahan thinks that at least a theoretical basis for recognizing future claims can be found in the necessary biological link between generations, each in turn dependent upon the other: "... later generations exist because of burdens assumed by earlier generations . . . To live at all is to be linked in an intricate way to the past and to be a determinant of the future."⁴¹ We owe to future generations at least what we have been given by those who

preceded us: namely, the possibility of life and survival. The more distant generations become from our ability to know what to desire for them, or how to protect them from harm, the more justified we are in discounting any claims or obligations they have on the living. Golding writes:

"If we have an obligation to distant future generations it is an obligation not to plan for them . . . The more distant the generation we focus upon, the less likely it is that we have an obligation to promote its good. We should be both ethically and practically well-advised to set our sights on more immediate generations and, perhaps, solely upon our immediate posterity. After all, even if we do have obligations to future generations, our obligations to immediate posterity are undoubtedly much clearer."⁴⁵

Callahan insists, however, that there is a difference between positive obligations to enhance future lives, and negative obligations to avoid causing harm. His moral logic dictates: if present behavior induces hazards, then they must be avoided. The logic applies, he cautions, only when the hazards are established by proof. He also thinks it reasonable to suppose that--no matter how remote in time--future generations will share fundamental human social ideals: a will to life, basic nourishment and protection, intelligence exercised by

good minds, and some social-ethical-political order.⁴⁶

The need to balance obligations to future generations with claims of the living requires the resolution of many ethical dilemmas about conflicting values, duties, and rights. Callahan suggests this principle as a partial solution:

"One thing that can be said for the present generation over against future generations, is that they have existing rights: the right to life, liberty and the pursuit of happiness (to choose one familiar formulation). They are here and the future generations are not. The claim of future generations against is a conditional claim, in the sense that it depends upon their existing to make the claim. That we know they will exist is enough to determine that their claim is not a fictitious one; but it is conditional in the sense that a number of conditions have to be fulfilled before the claim can be entered . . ."⁴¹

Be that as it may, the living do not have absolute priority of claims. Their claims do not extend to a "surplus exercise of rights which goes well beyond what is minimally or even moderately necessary for a decent human life."⁴¹ Individuals differ, to be sure, in their choice of a valid and meaningful decency in their quality of life. An acceptable exercise of individual rights ought to be judged by whether it jeopardizes rights that future generations will claim, and that we now claim.

On the basis of the kind of analysis conducted by Golding and Callahan, at least three ethical norms appear to govern any consideration of the acceptability of a legacy-of-risks to future generations:

- (1) Those risks should not be induced by an established, proven hazard that would jeopardize the very existence of future generations, immediate or remote.
- (2) Those risks should not jeopardize the possibility of future generations to exercise fundamental rights necessary for a moderately decent quality of life.
- (3) Those anticipated risks should neither impose excessive costs, nor exact sacrifices of existing fundamental rights among the living, nor preempt choices of future generations by imposing a legacy with no options to change present decisions.

BIOETHICAL CRITERIA FOR AN ACCEPTABLE RISK-LEGACY FROM NUCLEAR WASTES

From a bioethical perspective, criteria for determining the acceptability of future risks from radioactive wastes should derive from the ethical norms which govern any legacy of risk. Alterations in our

genetic constitution by genetic surgery and drastic engineering, or failure to provide for a sustainable population growth, both have a far more direct and potentially hazardous connection with prolonging the human species than risks from radioactive waste, public perception notwithstanding. An ethical methodology for assessing the acceptability of risks from radwastes must not only distinguish perceived risks from actual risks, but also give priority consideration to actual risks and costs imposed upon the living rather than to potential risks for future generations.

In conformity with the ethical norms outlined above, those who define acceptable risk-legacy criteria would have to establish whether the perceived hazard:

- (1) is actual rather than imaginary;
- (2) is so large and so permanent that it threatens the very existence of immediate and even distant generations;
- (3) deprives future generations of their fundamental rights to a decent quality of life;
- (4) imposes excessive costs on the living;
- (5) requires the living to sacrifice their fundamental rights

to a moderately decent quality of life;

- (6) preempts choices and fore-closes options for future generations.

One of Callahan's recommendations about a method of thinking responsibly concerning the future is that we should not imagine that future generations will be very dissimilar in their ideals and decision-making. Rather we should "take what we do know, and can reasonably project, and act accordingly."⁴¹

Among futurists, those with most experience in methods of assessing future risks are economists and investors, who have devised a method of discounting future income as an objective process of (1) weighing degrees of risk and (2) comparing equivalent kinds of risk to judge which option yields the greater benefit (or reduction of risk) per unit of investment/expenditure. If Callahan's recommendation has merit, two things are to be said about appropriating this method of discounting future income into bioethical methodology as a model for discounting future risk.

In the first place, burdened as it is with the uncertainties and expectations of a new cultural situation, ethical methodology requires already-proven, nonarbitrary

processes of risk assessment. The invidious distinction between objective facts and subjective values has obscured the social necessity of ethical discourse for decision-makers. Goods which depend for their fulfillment on human activity are expressed in concrete, measurable, visible, audible, culturally significant forms. Risks exist only in relation to recognizable and measurably expressed goods. They are therefore amenable to assessment by some measuring process.

In the second place, the public character of decisions affecting public health and safety require a visible method of judging the accountability of elected or appointed officials allocating public monies justly and equitably. Private persons have no a priori restrictions imposed upon their personal moral judgments concerning the value of a human life, their own or another's. But, by accepting a public trust, public officials accept a priori restrictions to be just and equitable in the allocation of fixed, limited, exhaustible resources. Given the objective to maximize health and safety by the expenditure of financial resources, there is an ethical imperative to use a method that can (1) assess degrees of risk from any assumed hazard, (2) compare equivalent kinds of risk, and (3) measure

the cost-effectiveness of one proposed reduction of risk to health vs another proposal. In the case of a legacy of future risks, if we do not use a proven method of measuring temporal

variations in the cost-effectiveness of reducing present vs future risks, public officials could not be held accountable for their decisions about resource allocation.

Conclusion

The nature of the nuclear waste problem is neither unique nor unprecedented. We have always lived with toxic elements in our environment, and they have not been sequestered with the skill and planning applied to radwastes.

As an ethical imperative, criteria for acceptable risk must avoid two potential extremes. On the one hand, they must avoid capitulation to requirements for acceptability dictated by a vocal minority whose

values and priorities neglect basic necessities of the many human beings now alive. On the other hand, they must avoid excessive preoccupation with imaginable risks to future generations of humans whose claim upon the intellectual and moral responsibility of existing persons has not yet been clearly defined.

Man does not live by safety alone. The ultimate challenge is to rediscover what else we live by.

References

1. W. D. Rowe, "Development of Approaches for Acceptable Levels of Risk," *Proceedings of Conference on Risk-Benefit Methodology, Asilomar Conference, Monterey, California, September, 1975.*
2. G. Pickering, "Ethics of Technology," *Proceedings of Conference on Technology, Values and Education, Terre Haute, Indiana: School of Technology Indiana State University, May 1971*, pp. 17-36.
3. A. Jonsen and L. Butler, "Public Ethics and Policy Making," *Hastings Center Report* 5 (4), 24 (Aug. 1975).
4. William S. Sahakian, *Ethics: An Introduction to Theories and Problems* (Barnes & Noble, New York, 1974), pp. 1-7. Cf. William K. Frankena, *Ethics* (Prentice-Hall, Inc., Englewood Cliffs, N.J., 1963).
5. H. D. Aiken, "Levels of Moral Discourse," in *Reason and Conduct* (Alfred Knopf, New York, 1962), pp. 69 ff.
 For a distinction between moralist and ideologist, see Aiken, "Morality and Ideology" in *Ethics and Society*, Richard T. DeGeorge, Ed. (Doubleday/Anchor, Garden City, NY, 1966), pp. 149-172.
 For an application of Aiken's four levels of moral discourse, cf. D. Callahan, *Abortion: Law, Choice and Morality* (Macmillan, New York, 1970), pp. 321-27.
6. H. Jonas, "Technology and Responsibility. Reflections on the New Tasks of Ethics," *Social Reserach* 40 (1), 31-54 (Spring, 1973).
7. A. Schweitzer, *Out of My Life and Thought* (New York, 1933), p. 188.
8. I. C. Bupp and J.-C. Derian, "Nuclear Reactor Safety: The Twilight of Probability," *Harvard Business School Bulletin*, 13 (March/April 1976).
9. R. Carson, *The Silent Spring* (Houghton Mifflin, Boston, 1962).
10. G. T. L. Land, *Grow or Die: The Unifying Principle of Transformation* (Random House, New York, 1973).
 Cf. "The Evolutionary Crisis," *The Futurist* 9 (2), 10-17 (February, 1975).
11. A. Gibson, "Technology As Sacrament," *The Ecumenist*, 92-97 (Sept.-Oct., 1973).
12. P. R. Ehrlich, *The Population Bomb* (Ballantine, New York, 1968 and 1971), P. R. Ehrlich, A. H. Ehrlich, and J. P. Holdren, *Human Ecology: Problems and Solutions* (W. H. Freeman, San Francisco, 1973), P. Ehrlich, *The End of Affluence: A Blueprint for Your Future* (Ballantine, New York, 1974), D. Meadows, D. Meadows, et al., *The Limits to Growth: A Report for the*

- Club of Rome's Project on the Predicament of Mankind* (Universe Books, New York, 1972).
13. G. Hardin, "The Tragedy of the Commons," *Science* 162, 1243-1248 (13 December 1968). Reprinted in *Exploring New Ethics for Survival: The Voyage of the Spaceship Beagle* (Penguin, New York, 1972), pp. 250-64. Cf. J. B. Cobb, *Is It Too Late: A Theology of Ecology* (Bruce, Beverly Hills, 1972), *Earth Might Be Fair*, I. Barbour, Ed. (Prentice-Hall, Englewood Cliffs, 1972), and *The Environmental Crisis*, H. Helfrich, Ed. (Yale Univ. Press, New Haven, 1970).
 14. W. O. Lowrance, *Of Acceptable Risk* (William Kaufmann, Inc., Los Altos, 1976), pp. 1 ff. E. D. Gray in *Proceedings of Nuclear Waste Management Conference, October, 1976* (Springfield, Va.: National Technical Information Service, 1976).
 15. D. Brower, Sierra Club literature, cited in T. Derr, *Ecology and Human Need* (Westminster, Philadelphia, 1973 and 1975), pp. 46 ff.
 16. C. J. Glacken, "Man's Place in Nature in Recent Western Thought," in *This Little Planet*, M. Hamilton, Ed. (Charles Scribner's Sons, New York, 1970), pp. 163-20. Cf. also G. P. Marsh, *Man and Nature*, D. Lowenthal, Ed. (Belknap Press of Harvard Univ. Press, Cambridge, Mass, 1965), pp. 42-43.
 17. H. P. Santmire, *Brother Earth: Nature, God, and Ecology in Time of Crisis* (Thomas Nelson and Sons, New York, 1970).
 18. L. White, "The Historical Roots of Our Ecologic Crisis," *Science* 155 (1203-1207) (10 March 1967). Reprinted in L. White, *Machino ex Deo* (MIT Press, Cambridge, Mass., 1968), in *The Environmental Handbook*, G. De Bell, Ed. (Ballantine, New York, 1970), and in *Ecology and Religion in History*, D. Spring and E. Spring, Eds. (Harper and Row Torchbook, New York, 1974), pp. 15-31.
 19. L. White, "Continuing the Conversation," *Western Man and Environmental Ethics*, I. Barbour, Ed. (Redding, Mass., 1973), p. 55.
 20. Cf. J. Needham, *Science and Civilization in China*, Vol. II (Cambridge, 1956), p. 69. Cited in *Ecology and Religion in History*, n. 18 above.
 21. H. Chatley, "Feng-Shui" in *Encyclopedia Sinica*, S. Couling, Ed. (Shanghai, 1917). Cited by Y.-F. Tuan, "Discrepancies Between Environmental Attitude and Behavior: Examples from Europe and China," in *Ecology and Religion in History*, n. 18 above, p. 100.

22. Y.-F. Tuan, op. cit., pp. 99 ff.
23. R. Dubos, "Franciscan Conservation versus Benedictine Stewardship," *A God Within* (Charles Scribner's Sons, New York, 1972). Reprinted in *Ecology and Religion in History*, pp. 114-136.
24. A. van Leeuwen, *Christianity in World History* (Charles Scribner's Sons, New York, 1965), pp. 419-20. (First Dutch edition, 1954.)
25. H. Cox, *The Secular City* (Macmillan, New York, 1965), p. 82.
26. L. White, *Medieval Technology and Social Change* (Clarendon Press, London, 1962).
27. A. Toynbee, "The Religious Background of the Present Environmental Crisis," in *International Journal of Environmental Studies* 3, 141-146 (1972). Reprinted in *Ecology and Religion in History*, pp. 137-149.
28. L. Montcrief, "The Cultural Basis for our Environmental Crisis," *Science* 170, 508-512 (30 Oct. 1970). Reprinted in *Ecology and Religion in History*, pp. 76-90.
29. Ibid. Cf. Derr, op. cit., pp. 28-33.
30. J. Barr, "Man and Nature: The Ecological Controversy and the Old Testament," in *Ecology and Religion in History*, pp. 48-75.
31. Derr, op. cit., p. 32.
32. G. Feinberg, "Long-Range Goals and the Environment," *The Futurist*, 241-246 (Dec., 1971). G. L. Land, *Grow or Die: The Unifying Principle of Transformation*. Cf. n. 10 above.
33. O. Bettman, *The Good Old Days--They Were Terrible!* (Random House, New York, 1974).
34. J. J. McKetta, "The World Doesn't End Here!" (Council for Environmental Balance, Inc., Louisville, Ky., 1974). ". . . 93% of the CO comes from trees and greeneries (3.5 billion tons/yr). Only 7% comes from man (?70 million tons/yr)."
35. W. Lowrance, op. cit., pp. 7 ff.
36. Cited by Derr, op. cit., p. 85.
37. Ibid., pp. 85, 82.
38. R. Dubos, "Reasons for Hope," in *Finite Resources for a Human Future*, I. Barbour, Ed. (Augsburg, Minneapolis, 1976), pp. 152-53.
39. H. Kahn, "Two Characteristic Current Views on Technological and Economic Growth," *The Futurist*, 335-38 (Dec. 1975) (adapted from a Hudson Institute Document).

40. M. Golding, "Obligations to Future Generations, *The Monist* 56, 85-99 (Jan. 1972). He notes, after citing a reference to a previous article, "Ethical Issues in Biological Engineering," that "I know of no other explicit discussion of the topic."
Thomas Derr also notes, in preparing his chapter, "The Obligation to the Future," that, "judging from the literature I have explored I would risk the guess that nothing has been written about the bases of this obligation to our descendants in managing our environment," *Ecology and Human Need*, pp. 89-90.
41. D. Callahan, "What Obligations Do We Have To Future Generations?" *American Ecclesiastical Review* 164, 265-280 (April, 1971). The works of Golding and Derr are cited in n. 40 above.
42. J. Cohen, "Why Benefit-Risk Analysis?" *Health Physics Society Midyear Topical Symposium, November, 1971*. The Asilmar Conference of September, 1975 (cf. n. 1 above) was an indication of increasing interest in the methodology.
43. Callahan, op. cit., p. 267 (n. 41 above)
44. Callahan's essay is substantially a commentary on Golding's article.
45. Golding, op. cit., pp. 97-98.
46. Callahan, op. cit., pp. 273-274.

Appendix

The bioethical perspective adopted throughout this study represents a departure from that which is considered "mainstream" among current specialists in the area of bioethics. In their view, the major problems with which bioethics should deal are: abortion, death and dying, genetic engineering, human experimentation, behavior modification, etc. However, I think such problems are more properly the domain of biomedical ethics. By contrast, bioethics should concern problems which arise from, and gravitate around, the quality of life of the biosphere--considered as a total system of conditions affecting the public health and safety of living organisms, primarily human persons.

To address a relatively new set of recognizable problems, bioethics needs a more comprehensive methodology for (1) formulating those problems and (2) devising adequate social structures and policies for dealing with them. We do not lack ethical norms; indeed, we have more than we know how to implement coherently. The primary

need is to formulate the problems about our common humanity under present global conditions and in a cultural climate of crisis in which an upward spiral of public attention to problems is directly connected with a downward spiral in a public understanding of those problems. A model for an adequate methodology is admittedly secondary, yet needed.

To that end, the attached design illustrates the complexities of decision making. It is adapted from the models and rationale offered by

1. E. Laszlo, *A Strategy for the Future: The Systems Approach to World Order* (George Braziller, New York, 1974), pp. 144 ff.
2. M. Mesarovic and E. Pestel, *Mankind at the Turning Point: Second Report to the Club of Rome* (Hutchinson, London, 1975), pp. 48 ff.
3. J. T. Hanford, "Systems Theory for Bioethics," Unpublished MS (1974).

Fig. A.1. Design for a total-system bioethics.