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RISK ASSESSMENT AND SOCIETAL CHOICES

Harry J. Otway

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Many countries are experiencing a period in which traditional values are being questioned; plans for further technological progress are being met by a variety of demands for a closer examination of the benefits and risks of large-scale technologies. In this paper the concepts of risk assessment are presented and a model is proposed which illustrates the importance of socio-psychological mechanisms in the acceptance of technological risks. The research plan of the Joint IAEA/IIASA Research Project is outlined: this work is directed toward gaining an improved understanding of how societies judge the acceptability of technologies and how societal attitudes and anticipated responses may be better integrated into the decision-making process. Some preliminary results are reported.

I. BACKGROUND

Standards of living have improved considerably during this century, largely due to the benefits made possible through the development and deployment of new technologies. As technological systems became larger, and more complex, they have offered increasingly attractive benefits which have become an integral part of life, thereby creating demands for more progress. This process of reinforcement has lead to increasingly complex, and therefore fragile systems, which have become fundamental to sustaining the social fabric.

With this increase in scale the negative side-effects of technology, which detract from the societal benefits, began to receive more attention. Some of these side-effects have been rather obvious, such as new safety hazards, while others have been more subtle and, therefore, more difficult to predict and detect; e.g., mental health problems, new health hazards, complicated environmental interactions, technological unemployment, mental health problems, changes in basic social institutions.

Consequently there appears to be a growing awareness that increased consumption of goods and services has not brought a commensurate increase in "happiness." Plans for further progress are being met by a variety of

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* The views expressed in this paper are those of the author, and do not necessarily reflect those of the Project Sponsors.

**Joint IAEA/IIASA Research Project, International Atomic Energy Agency, Vienna, Austria.

individual and group demands for a closer examination of the risks and benefits of science and technology; there appears to be a gradually evolving social structure which tends to question much that is innovative as being potentially harmful. The patterns of public concern that have emerged in technologically advanced nations are also being observed in developing countries as they attain higher levels of productivity.

This has lead to a situation characterized by conflict; one segment of society may sponsor a proposal intended to fulfill a perceived societal need while other groups may be working actively in opposition - with different perceptions of their needs. Obviously technology cannot expand indiscriminately with society awaiting the results of operation to learn the nature and magnitude of the side-effects; however, neither can all further progress be rejected arbitrarily.

Societal-level decisions are especially important in the energy sector. Energy is a fundamental good in modern societies, energy production systems are among the larger-scale technological applications and the energy crisis, with its far-reaching effects, has limited available strategies and reduced the time available for exploring options. This is the background for the formation of the Joint IAEA/IIASA Research Project which is sponsored by the International Atomic Energy Agency (IAEA), the International Institute for Applied Systems Analysis (IIASA) and certain IAEA Member States; information on sponsorship and staffing is given in the Appendix.

The primary objective of the Joint Project is to do research directed toward gaining an improved understanding of how societies judge the acceptability of new technologies and how societal attitudes, and anticipated responses, may be integrated into the decision-making process. This has been referred to as the embedding of energy systems into the sociosphere (Häfele, 1974).

II. RISK ASSESSMENT CONCEPTS

A digression might be in order to introduce the concepts of risk assessment. These concepts have developed independently in a variety of disciplines, publishing in many languages, with the expected differences in usage and meaning. There is no intent to provide rigorous definitions; these will be evolved as interdisciplinary and international efforts proceed. Risk* will here refer to the undesirable effects associated with a specific activity considered in connection with their respective uncertainties. Risk is therefore a probabilistic term and has often been used as the statistically expected value of loss; for example, the probability of an average individual's chance of death, per year, from transportation accidents or the total risk (sum of individual risks) in a population group.** The most obvious risks, and easiest to conceptualise, are those relating to the health and safety of man and effects upon his environment, although there are many other effects, which in connection with their uncertainties can be considered as risks.

Risk assessment may be defined as any process in which risk considerations play an important rôle in forming an input to decision making. Risk assessments are made on a variety of levels, i.e., individual, group, societal, etc. and Kates (1974) has pointed out that the process may vary from highly intuitive to very formal. This typology of risk assessments, summarised in Table I, might range from the individual's intuitive feeling that it is safe to cross a street to a numerical analysis which serves as the basis for recommendations. Risk assessment has been described by Otway (1973) as occurring in two sub-tasks: risk estimation and risk evaluation, each of which may have the same range of intuitive-formal, individual-societal character.

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* It is not considered necessary here to make a distinction between situations of the first kind, i.e., where the probabilities are known in principle, and those where the probabilities themselves are uncertain.

** This is somewhat too simple because the statistically expected value neglects the importance of the absolute magnitude of loss. It is known that societal preferences for risk acceptance may be widely different for events which have the same statistically expected value of loss but with different absolute magnitudes. Thus utility functions must also be considered when expressing risk levels. For an elementary explanation see, for example, Borch (1968). An application to energy system risks may be found in Papp et al., (1974).

TABLE I

RISK ASSESSMENT MODES

(Kates, 1974)

Mode	
0 step	No estimation, no evaluation There is no risk. Nothing you can do about it, so why estimate it.
1 step	Evaluation without estimation Decide whether risk is acceptable or not compared to other risks or benefits.
2 step	Estimation of risk, then evaluation Calculate likelihood of risk, then compare with other risks or benefits.
3 step	Fractionate risk, estimate combinations of individual risks, evaluate Reduce events to components. Calculate likelihood of event components and of consequences, combine, estimate risk, then compare with other risks or benefits.

Risk Estimation

Risk Estimation may be thought of as the identification of the second (and higher) order consequences of a decision and the subsequent estimation of the magnitude of the associated risks. For example, some of the earlier risk estimates for energy systems were made in the nuclear field in Canada (Siddall, 1959), the UK (Farmer, 1967; Beattie, 1967) and in the U.S.A. (Otway et al., 1969 and 1971). Starr et al. (1972) made a comparison of the risks from nuclear and fossil-fueled generating systems. The most recent, and by far the most comprehensive, risk estimates for energy systems are those of the U.S. AEC-sponsored "Rasmussen Study" (1974) which treated the risk of accidents in light-water reactor nuclear power plants. All of the aforementioned efforts indicated that the risks from these energy production systems were low in comparison to other risks common in society.

Risk Evaluation

This is the complex process of anticipating the societal response to risks; it is based upon an understanding of the relevant societal attitudes and preferences. This could be termed the "acceptability of risk."

Traditionally this has tended to consist of comparing estimates of risk with the levels of other prevalent risks which are already accepted by the society. For example, in the risk estimation studies cited earlier, Farmer and Beattie compared the predicted number of thyroid carcinomas due to iodine-131 exposure following reactor accidents to rates of naturally-induced thyroid cancers. Otway et al. used accident statistics and natural genetic mutation rates as a basis. Starr et al. added another dimension and proposed the relationship shown in Figure 1 for dividing risks into acceptable and unacceptable as a function of the perceived associated economic benefit. The Rasmussen Study compared the statistically expected value of nuclear accident risks with a variety of other accident risks and natural hazard risks. In addition, the disutility of infrequent, large-consequence accidents was also evaluated by similar comparisons over consequence magnitude and frequency of occurrence (Figure 2).

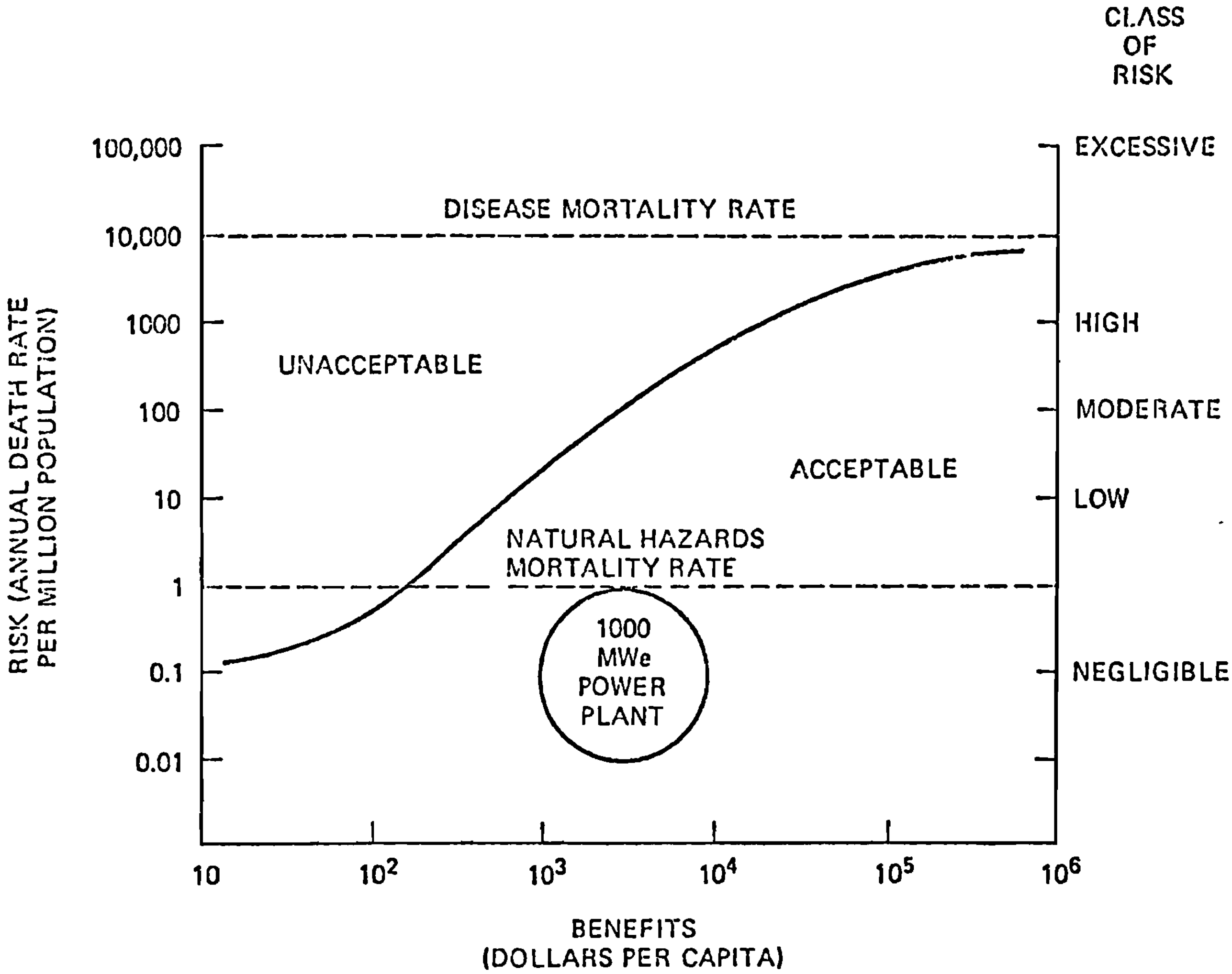

FIG. 1 HYPOTHETICAL RELATION OF INVOLUNTARY RISK VS. BENEFIT (STARR, 1972 AND 1974)

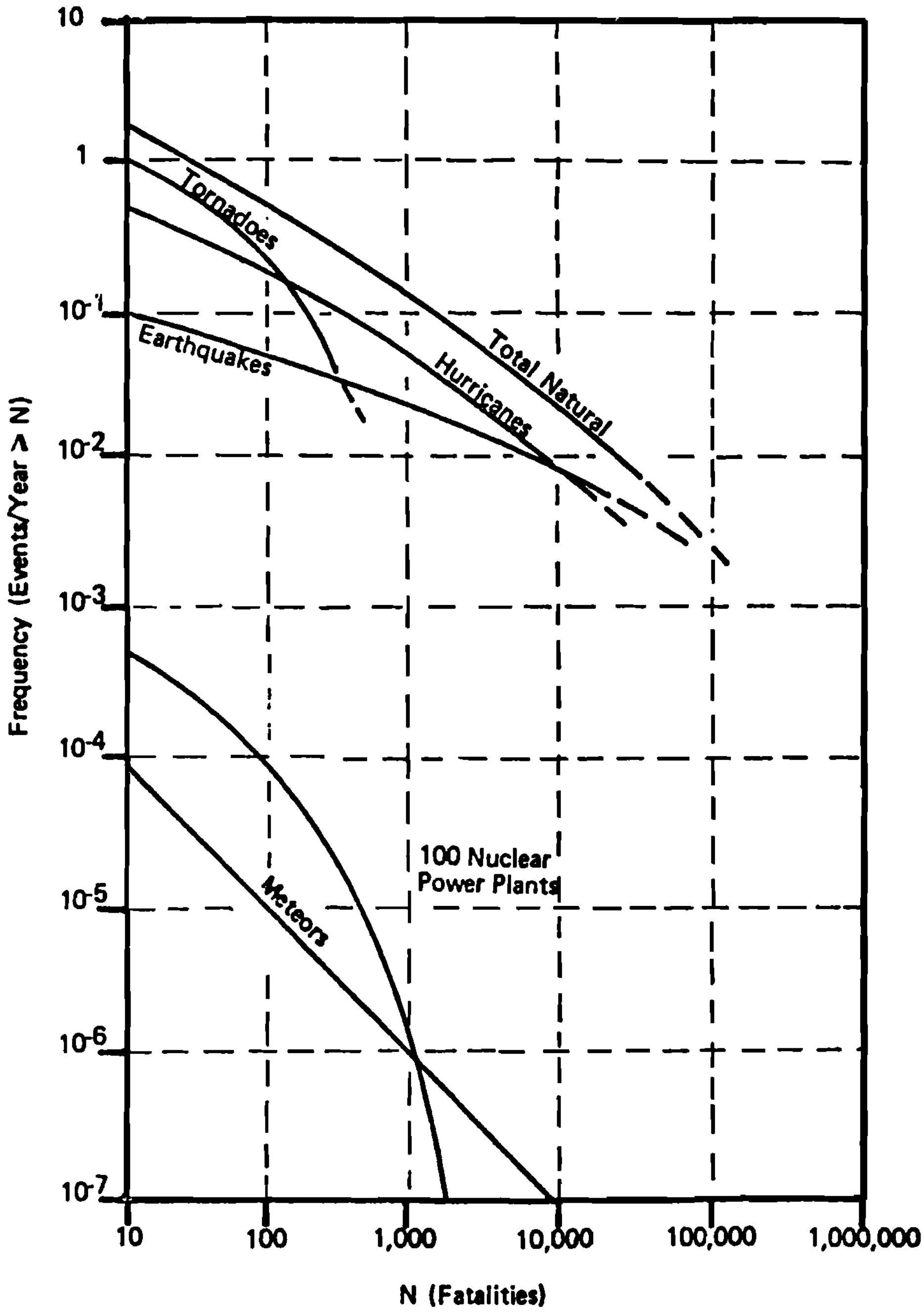

FIG. 2 FREQUENCY OF NATURAL EVENTS WITH FATALITIES GREATER THAN N (WASH-1400)

The tacit assumptions in the foregoing approaches to risk evaluation are that the preferences that society has revealed through its historical acceptance of risks can be extracted from statistical data, extrapolated to the future, and compared with other types of risk. Raiffa (1968) has pointed out some of the difficulties of this approach. The experience in the nuclear energy field would also indicate a problem in this respect. Estimated nuclear risks have been virtually negligible when compared to other risks which are widely accepted by society. The comparison of nuclear risk estimates with, for example, transportation risks or natural hazard risks is perhaps essentially meaningless because, for a variety of conscious and subconscious reasons, the latter risks are accepted while the nuclear risks are being frequently challenged. Obviously there are qualitative differences as well as quantitative (Montague and Beardsworth, 1974) and the quantitative data base available for deriving revealed preferences cannot, without a thorough consideration of psychological factors, adequately reflect the qualitative (Otway and Cohen, 1975).

The Dimensions of Risk

There is still much to be learned about the dimensions of risk and its acceptance. It is clear that the perception of risks is an important factor: that the subjective assessments of risk are more influential in acceptance than are objective risk estimates or measurements. It is known that man is, in general, a poor intuitive statistician and tends to mis-estimate probabilities, and therefore risks, due to psychologically determined factors (Edwards, 1968; Murphy and Winkler, 1973; Sjöberg, 1974). There are many factors which play a part in influencing perception although their relative importance is not well known. These include the degree to which a feeling of individual control over the risk or the outcome is felt, the physical nature of the risk itself, the degree to which a commensurate benefit is felt to accrue to those at risk, whether the outcome is composed of a chain of independent probabilities or a single event, the ability to imagine the risk or benefit, etc. There has been a paucity of research in the behavioural and social sciences on the reaction, fears, attitudes and beliefs of society with respect to the perception and acceptance of technological risks. One promising approach for learning about these phenomena is the application of sociometric and psychometric techniques which will be discussed later in this paper.

III. RISK AND SOCIETAL CHOICES

Figure 3 is suggested as a description, on the societal level, of the information flow involved in a risk assessment of a new, large-scale application of technology.* This figure is by no means precise nor are these relationships accurately known; the intent is to provide a discussion aide in order to point out areas of research interest.

Sponsor Acceptability

It is assumed that the proposed application is aimed at meeting some specific societal need (such as energy) and that the proposal is sponsored by some segment of society such as private industry or government. Simply stated, the sponsor will have made his internal decision that the application is capable, with a high degree of certainty, of providing the primary benefit intended and is, therefore, acceptable to him.

The decision to proceed with this project carries with it several implied consequences (second order, or side-effects) the sponsor must also find acceptable. These side-effects could include, for example, radioactive, chemical and thermal discharges affecting man and his environment, accident hazards, aesthetic effects, land-use commitments, natural resource utilization, etc. He most likely has not considered these side-effects as "risk" in the probabilistic sense in which they have been defined.** He has certainly considered the absolute, or nominal, magnitude of these effects and is fairly confident that they will satisfy the appropriate regulatory standards. He will also have considered, to the extent that the information was known and available to him, the preferences of society for this application and the anticipated societal responses.

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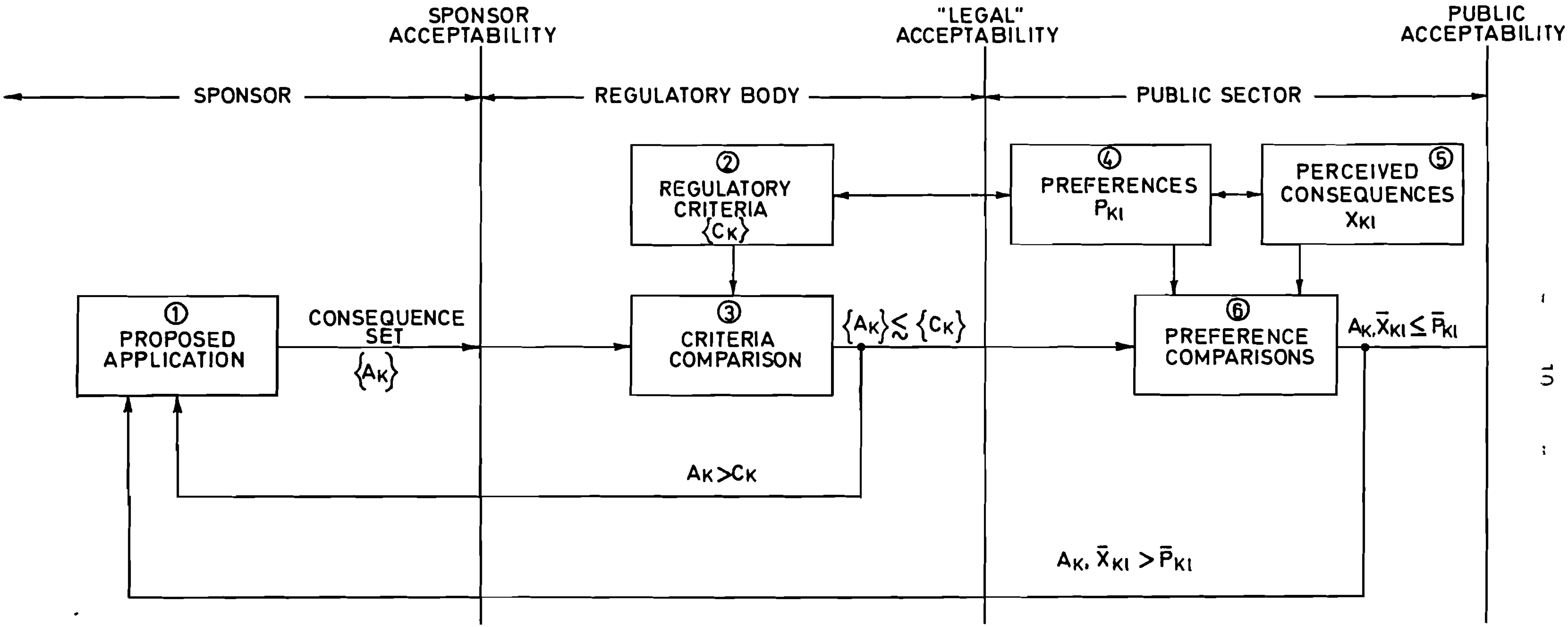
* As an interesting aside it might be noted that Fig. 3 closely parallels the structural hypothesis of mental mechanisms proposed by Freud (1925).

** See Winkler (1973) for a discussion of the merits of deterministic vs. probabilistic models.



NOTE: MANY INTEREST GROUPS, I
$\lesssim$ IS FAVOURABLE COMPARISON
$>$ IS UNFAVOURABLE COMPARISON
— INDICATES WEIGHTED AVERAGE
WIDTH OF FEEDBACK CHANNELS MIGHT BE ZERO.

FIG. 3 RISK ASSESSMENT: INFORMATION FLOW MODEL

At this stage the sponsor submits the proposal to the responsible regulatory authorities and the line of "sponsor acceptability" is formally crossed.

"Legal Acceptability"

It is now necessary to compare (Box 3, Fig. 3) the predicted consequences of the proposed application with the applicable standards (Box 2) for regulating these effects. The actual comparison may be rather straightforward once the predictions of the effects have been made and verified.

The complicated part is the derivation of the criteria, or standards, which are shown in Fig. 3 as magically originating in Box 2. A desirable objective is to set rational standards so that unduly large resources are not invested to further reduce risks which are already insignificant. Where large investments are made in safety to provide marginally small reduction in risk then the expenditure is not efficiently beneficial to society and should be made elsewhere where the marginal risk reduction (risk reduction/unit expenditure) could be greater. This goal is sometimes referred to as balanced risk reduction (see Sinclair et al., 1972; Jammet et al., 1973).

This question of setting standards is not a trivial one (Keeney, 1974). A good deal of information is required such as the relationship between expected societal benefit and allowable risk levels, the "value" of risk, the relationship between actual levels of risk and these levels as perceived by those at risk, etc. This is an area where research is needed in order to use risk concepts more effectively in standard setting (Bresson, Fagnani and Morlat, 1974).

Note that at the output side of the comparison box a feedback channel is shown leading back to the original proposal in the event of failure to satisfy criteria. This feedback would act to change the implied consequences until the criteria are met. When the proposal satisfies the criteria we can say that the line of legal acceptability has been crossed and the proposal, for all practical purposes, first enters the public sector where acceptability will include the consideration of several additional factors.

Public Acceptability

Here the responses of individuals, and various interested groups, to the proposal gradually emerge. These groups use multiply-determined criteria to judge, and perhaps challenge, technological advances; that is, their preferences (Box 4) reflect their rational assessment of the facts (consequences) as they know them, their perception of these consequences (Box 5), and the effects of factors which may be buried deep in the nature of the groups themselves. These preferences are formed, in part, in the light of the past experiences of the individual and group.

It is important to note that this complex process operates on many organizational levels: the individual, the group, the societal or national, and perhaps even the international. In Figure 3 a number of interest groups is postulated which includes all these levels of interest. Box 6 shows the process of comparison which has been described. Here, the acceptability of the proposal to each group must be considered. In addition, by some unspecified process, each interest group's preference comparisons influence the final decision.

The interest group itself may be viewed as a confluence of social systems including individual responses, socio-psychological mechanisms, cultural factors, political considerations, economic influences and the information input of the scientific community. The interest group represents the focal point of the interactions of these various systems.

A generalization is that the individual response to a fear-provoking stimulus may lead to a variety of healthy or unhealthy defenses. The two most primitive are known as "flight or fight": apathetic physical and emotional withdrawal and denial that threat exists, or a readiness to retaliate. The latter response accounts in part for the opposition of the group to what is perceived as an external threat. In addition to external threats internal fears and anxieties may be projected onto a symbolic external object. As these fears are expressed, the individual finds others who think and act similarly.

An interest group reflects, to varying degrees, elements of its members' individual responses, characteristics of its societal-cultural environment, and an indication of the information it has received form the scientific community. The group, however, has its own characteristcs. Observations seem to support the following generalizations:

a) interest groups tend to form around affect-laden social-environmental concerns;

b) they tend to be solution-oriented rather than problem-oriented, inclined toward a dialectic adversary position rather than collaborative exchanges;

c) communication patterns are often distorted, especially in groups with a vertical status and power hierarchy;

d) new information may be accepted or rejected contingent upon the support it provides for group values and beliefs;

e) behavioural responses of members are influenced by the group so the strength and integrity of individual values is weakened.

Thus the interest group tends to be a body of persons emotionally committed to their position and screening factual information according to the utility it has for their position. They may be matched feature for feature by other groups supporting diametrically opposed positions. (Pahner, 1974, described some behavioural aspects of interest groups.)

Inter-relationships have been indicated in Figure 3 by feedback loops which show that an unfavourable comparison in the public sector can act to change the proposal, and further, that there may be some interactions between societal preferences and the perception of risks which could act to influence regulatory standards.

Summary

To summarize the discussion of Figure 3, the research activities of the Joint Project include the application of risk assessment concepts to standard setting (Box 2), the study of the perception of technological risks and benefit

(Box 5), methods for determining group and societal preferences relating to risk acceptance (Box 4) and the group dynamics and transmission of technical information which are involved in the comparison process (Box 6). This work will be discussed in more detail in the following section.

IV. RESEARCH PROGRAMME AND PRELIMINARY RESULTS

Figure 3 was used to point out areas where additional research could improve the application of risk assessment to making societal-level choices regarding the acceptability of new technologies. This Section will indicate specific lines of research being pursued by the Joint IAEA/IIASA Research Project and summarize some preliminary results.

Historical Examples of Risk Acceptance

Societal problems caused by technological progress are of acute concern to behavioural scientists and some specific historical examples may be identified. Some items of interest in understanding the general mechanisms of societal adaptation to new threats are: how the impacts of technological progress influenced social dynamics; how the institutions of the society reacted; what mechanisms were evolved to absorb these shocks; how people got the pertinent information and formed their opinions; how their perceptions of the hazard were formed and how they compared to reality.

A case study is being made treating one modern society and some traditional population groups in order to elucidate the behavioural aspects of adaptation to new threats. This study will also provide inputs into the design of surveys directed towards understanding risk phenomena. A survey of the literature reporting case studies relating to the impacts of technological progress on social systems has been completed (Velimirovic, 1975).

This work relates to testing the overall structure of Figure 3, as observed in practice, and provides background material for developing information related to Boxes 5 and 6.

The Estimation of Risk from Large Consequence - Low Probability Events

Some risk estimates have been made for large-consequence accidents which have a low probability of occurrence. This is a crucial topic in the case of nuclear power plants where the experimental data base required to make reliable estimates is much too small. It is difficult to deal with this problem using conventional mathematical methods. Therefore, the applicability of new methods, such as fuzzy set theory (e.g., Zadeh, 1973 and 1974), is being investigated. This is related to the estimation of consequences, Box 1, and the development of regulatory criteria, Box 2.

Theoretical Approaches to Risk Evaluation

One of the important factors in using risk-benefit principles in setting standards is the problem of expressing unlike variables in a consistant set of units so that approximate comparisons can be made. This is especially difficult when it is necessary to evaluate risks that involve the possible loss of life. Therefore, the Pareto theoretical approach to the evaluation of such risks is being developed and the appropriateness of using Pareto criteria for the treatment of statistically and non-statistically distributed risks is being examined. (This non-random distribution of risks and benefits within society has been an issue in many industrial siting controversies.) The effect of further variations will also be examined, such as how to treat risks that will occur in the future, or even be taken by future generations, where the benefits are received in the present.

Approximations of the individual's indifference function, or trade-off between perceived risk and required compensation, may be obtained either through controlled experimentation (surveys) or through the use of market data. In the design of experiments it is useful to first determine theoretically the meaning of the responses from the standpoint of Pareto welfare maximization. An attempt is being made to model the individual's "rational" responses to the acceptance of risks, including the subjective factors which might influence this response. Of particular interest is the complexity of the risk problem when the uncertainties involve life or death and thus the utility of compensation and the disutility of the risk may become nonadditive (Raiffa, 1969). A survey has been completed of the experience in France and the USA in applying cost-benefit techniques to the evaluation of projects which may alter human mortality

(Linnerooth, 1975). These theoretical treatments are primarily related to standard setting, Box 2.

Methodologies for Determining Societal Preferences

Two basic methods for determining societal preferences are the "revealed" preferences approach which relies upon historical statistical data, and the survey approach based upon sociometric and psychometric techniques. For example, Starr (1969 and 1974) has indicated the existence of preferences for the acceptance of technological risk which were based upon analysis of accident statistics. Psychometric techniques have yielded consistent results for societal preferences with respect to other types of risk. Both techniques are being critically reviewed to determine their limitations and to recommend directions for longer-term research (related to Box 4, Fig. 3).

Preliminary analyses (Otway and Cohen, 1975) indicate that the results of the Starr technique, which emphasises the mortality risks associated with various activities, are excessively sensitive to the assumptions made and handling of the data.

The Perception of Technological Risks

As discussed earlier, the perception of risks is a crucial factor in influencing societal response. Psychometric and sociometric techniques show a great deal of promise for gaining an improved understanding of how specific risks are perceived, which factors influence perception and their relative importance.

Golant and Burton (1969), working in natural hazards research, developed a Risk Avoidance Response Survey designed to rank various types of hazards (physical, social and natural) in terms of the perceived threat. This test was administered in Ontario, Canada, and produced the risk avoidance ranking shown in Table II. Correlations were done to determine the effects of various variables upon the rank order. The most significant factor was found to be the respondants experience, or lack of it, with a specific hazard. The rank-size correlation illustrating the effect of experience was 0.45.

TABLE II

RANKING OF HAZARDS BASED ON RESPONDENTS GREATEST AVOIDANCE MEASURES

TOTAL CANADIAN SAMPLE

(Golant and Burton, 1969)

Rank	Hazard
1	Auto Accident (Physical)
2	Attacked and Robbed (Physical)
3	Tornado (Natural)
4	Forest Fire (Natural)
5	Earthquake (Natural)
6	Failing in School or Job (Social)
7	Illness (Physical)
8	Loneliness (Social)
9	Flood (Natural)
10	Public Embarrassment (Social)
11	Being Disliked by Someone You Admire (Social)
12	Thirst (Physical)

This experiment has been applied in Austria to gain experience in this type of survey, to test computer programmes for data reduction and to check reproducibility. The avoidance ranking for the Austrian sample is presented in Table III (Otway, Maderthaner and Guttman, 1975). The overall cross-cultural comparison was found to be 0.62. The effect of experience upon perception was not well reproduced in this sample with a rank-size correlation between experienced and inexperienced respondants of 0.82. The most significant variable affecting the Austrian rank order was found to be the Ss self-rated ability to imagine himself in a specific hazard situation (rank-size correlation 0.59). In general, the American sample showed the highest avoidance response to natural hazards, whereas for the Austrian sample physical hazards were the most avoided.

A new survey which incorporates a magnitude estimation scale, allowing a numerical measure of disutility, has been developed and is being checked for feasibility. A significantly larger number of risk-related variables are included and paired comparisons are being used. This design draws upon the work of Wyler, Masuda and Holmes (1968), Holmes and Rahe (1967) and Holmes and Masuda (1973) on the perception of health and social hazards and is related to Boxes 4 and 5 of Figure 3.

<u>The Determination of Societal Preferences</u>

The use of field surveys for measuring societal preferences is closely related to the work on risk perception: the techniques described above will be modified for this purpose.

An effort is also being made to determine societal preferences as revealed by recorded data. As mentioned earlier (Otway and Cohen, 1975), preliminary results indicate that, since preferences for risk acceptance are multiply determined, historical accident data using few variables (Starr, 1969 and 1974) may be inadequate to give a true picture of the effects of socio-psychological mechanisms. Preferences toward risk are multiply determined within a broader network of socio-psychological relationships and the attitudes of any culture toward risk can only be understood by knowing its position within this framework. This framework can be investigated by trans-cultural, in-depth analysis using an iterative process of empirical multi-variable analysis combined with behavioural theories. This technique has been used by Gaspari and Millendorfer (1973), of the Study Group for International Analyses (STUDIA), for

TABLE III

RANKING OF HAZARDS BASED ON RESPONDENTS GREATEST AVOIDANCE MEASURES

TOTAL AUSTRIAN SAMPLE

(Otway, Maderthaner and Guttmann, 1975)

Rank	Hazard
1	Illness (Physical)
2	Auto Accident (Physical)
3	Attacked and Robbed (Physical)
4	Earthquake (Natural)
5	Loneliness (Social)
6	Failing in School or Job (Social)
7	Flood (Natural)
8	Forest Fire (Natural)
9	Tornado (Natural)
10	Thirst (Physical)
11	Public Embarrassment (Social)
12	Being Disliked by Someone You Admire (Social)

investigating the structure of the General Production Function for European countries. In co-operation with the STUDIA group it will be extended to the determination of societal-level preferences related to risk acceptance. This effort will also help define inputs for the survey work which was described earlier. As a preliminary step an extensive data base covering fifteen countries has been compiled. This work is related to Boxes 4 and 5 of Figure 3.

Ellis and Keeney (1972) and Keeney (1973) have described an assessment of the preferences of government officials for such attributes as air emissions, health effects and mortality. The determination of interest group preferences by the estimation of a knowledgeable, impartial observer has been applied to nuclear power plant siting by Gros (1974) and Gros et al (1974). These methods will also be considered and results compared to those of the other methods.

Group Dynamics and Information Transmission

There is also the problem of how scientists develop and communicate information about environmental risks, and the part this information plays in societal assessment and response to risk, including interest group dynamics (Nizard and Tournon, 1972; Kates, 1974; Wilson, 1973). The mechanisms societies use in judging, and perhaps deciding to challenge, the acceptability of new technologies, which promise specific benefits but with the possibility of new apparent threats, are complex and rather poorly understood. In the specific case of nuclear power plants it has been observed that until a project is made known there is no pressing concern about nuclear hazards among most inhabitants of the area. Once the plans are announced, people soon become acquainted with thinking about the possible threats, real or imagined; they are forced by circumstances to form relevant opinions. The project then starts being judged on a number of levels: individual, group, community, national and perhaps even international. As the responses to the proposal gradually emerge it has been noted that various interest groups start to form, develop their sources of information and, in many cases, work actively to promote or oppose the proposed facility. The objections most often cited in opposition to peaceful nuclear energy programmes have been summarized by Häfele (1973) and a psychoanalytic viewpoint of the nuclear controversy has been presented by Guedeney and Mendel (1973).

Groups serve a mediating function between the individual and the larger society. People contact society and are, in turn, contacted by it through the small group. Just as it is difficult for an individual to influence the larger society, it is difficult for the larger society to mobilize the energies of the individual when he stands alone (Shepherd, 1964). Therefore, an understanding of small group dynamics is especially important in gaining an understanding of the societal acceptability of risks. Of special interest here is the rôle the group plays in weighting and aggregating individual preferences to form societal preferences.

Cross-Cultural Differences

Risk perception and societal preferences for risk acceptance would be expected to be dependent upon culturally determined factors; therefore, the results of this work will be examined for cross-cultural differences. It is anticipated that this could be made possible through the excellent international contacts of the sponsoring organizations and the multinational character of the Joint Project staff.

V. CONCLUSIONS

Though some efforts have been made toward placing technological risks in perspective through the comparison with other types of common risks, this approach is limited in its ability to consider the effects of socio-psychological mechanisms in risk acceptance. There has also been very little research done in the behavioural sciences in this respect.

As stated earlier, a primary objective of the Joint Project is to gain an improved understanding of how societies judge the acceptability of new technologies and how societal attitudes, and anticipated responses, may be integrated into the decision-making process. For this purpose, research is needed in the following areas: the perception of societal needs by individuals and groups, how risks and benefits are perceived and the nature and importance of the variables influencing perception, the group dynamics and information transmission involved in aggregating individual preferences into societal preferences, and methodologies for assessing societal preferences related to risk acceptance.

The Joint Project has made a start on research in these areas.

APPENDIX

ORGANIZATIONAL ASPECTS OF THE JOINT IAEA/IIASA RESEARCH PROJECT

Sponsorship

The Joint Project was formed in mid-1974 pursuant to an agreement between Dr. Sigvard Eklund, Director General of the IAEA, and Prof. Howard Raiffa, Director of the IIASA.

Professional staff for the Joint Project come from three sources approximately equal in their contributions: IAEA scientific staff, IIASA Research Scholars, and scientists from IAEA Member States seconded to the Project on a cost-free basis. The research programme outlined for the Project reflects a mixture of the specific interests of these three sources of sponsorship. The IAEA also provides office space and support service while the IIASA has contributed the services of additional well known consultants.

Organization

Organizationally the Project comes under the Energy Systems Project of the IIASA, led by Prof. Wolf Häfele, and the IAEA Department of Technical Operations - Division of Nuclear Safety and Environmental Protection respectively headed by Dr. Yuri Chernilin (Deputy Director General) and Dr. Jacques Servant (Division Director). Dr. H. J. Otway, IAEA, is Project Leader of the joint effort.

Staffing

As of February 1975 the Joint Project consisted of seven professional and two General Service staff. The IAEA and the IIASA are represented by two scientists each while Japan, U.S.A., Sweden and the U.K. have each provided seconded scientists. The Joint Project expects to reach a steady-state staffing level of about 11 scientists in mid-1975 with the addition of another IIASA Research Scholar and a secondment from France and two from the Federal Republic of Germany.

Contracts

Additional scientific support is obtained through IAEA-sponsored research contracts with the University of Vienna, Psychology Institute, and the Study Group for International Analyses, Vienna.

Miscellaneous Information

The following disciplines will be represented in the Joint Project:

Physics	Economics	Psychiatry
Public Health	Anthropology	Medicine
Engineering	Sociology	Psychology

Seven nationalities are represented in the Project and Project staff are proficient in a total of seven major languages: English, French, German, Italian, Japanese, Russian and Spanish.

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