THE DETERMINANTS OF ATTITUDE FORMATION: AN APPLICATION TO NUCLEAR POWER

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PREFACE

Risks have emerged as a major constraint to the introduction and development of technological systems. The work of the joint IAEA/IIASA research project (IAEA: International Atomic Energy Agency) is directed toward gaining an improved understanding of how societies judge the acceptability of new technologies and how objective information on risks, and the anticipated social response to them, may be considered in decision-making.

This paper presents a model of attitude formation and reports results of a pilot application to the case of attitudes toward nuclear power and the risks associated with nuclear power.

ABSTRACT

This paper presents an expectancy-value model which allows identification of the technological, psychological and social determinants of attitude formation. The utility of the model with respect to attitudes toward nuclear power, and attitudes toward the risks associated with nuclear power, was tested by an empirical application. Attitudes estimated from the model correlated highly ($r = 0.66$ and 0.76, respectively) and significantly ($p < 0.001$) with direct measures of these attitudes. An analysis of the cognitive structures underlying attitudes, including a comparison of sub-groups "pro" and "con" nuclear power, is reported. These groups were found to significantly differ in their beliefs concerning the benefits of nuclear power but not in their beliefs about the risks. A similar analysis of sub-groups relatively favourable and unfavourable toward nuclear power risks suggests that those who believe that people are involuntarily exposed to these risks, and in a passive way, also tend to judge the risks as being unacceptable.

INTRODUCTION

The social conflict that has surrounded technological development has demonstrated the importance of a formal consideration of social values in public policy decisions, such as those affecting regulatory criteria. The social response has, in many cases, focused upon the risks associated with such developments; one consequence has been to stimulate interest in risk assessment research. Risk assessment studies provide information for use in decisions relating to the management of risks; a conceptual framework for such studies has been developed by Otway (1973 and 1975) and Otway and Pahner (1976). One concern of such research is that of anticipating the totality of the social response to risk situations and in understanding the mechanisms underlying the formation of this response. Clearly, response is not based solely upon theoretical or statistical risk predictions but, rather, is multiply-determined through a variety of perceptual, information processing and learning functions which are instrumental in the formation of attitudes toward the technology and its risks.

The next section points out that attitudes toward an object are not directly related to specific behaviours with respect to that object; however, these attitudes do establish a predisposition to behave in a consistent manner with respect to that object. Thus attitudes provide an indication of the individual's overall response with respect to the object. By aggregating individuals, it becomes possible to describe the overall social response. The Fishbein model of attitude formation is briefly discussed; it is shown that the model can provide descriptive information on the relative importance of the technical, psychological and social factors which determine attitudes. This information allows insights into the differing perceptions of the object by different social groups.

This is followed by a section which summarizes the design of empirical studies to test the predictive validity of the model. The third section reports results of an empirical, pilot study which applied the attitude formation model to the specific case of attitudes toward nuclear power and toward nuclear power risks. The final section summarizes this work, suggests some conclusions which emerged, and outlines plans for its extension.

A THEORETICAL FRAMEWORK

A major difficulty in social psychology has been a failure to recognize that beliefs, attitudes, intentions and behaviours are different and distinct variables, with different determinants, but with stable and systematic relationships among them. Until very recently attitude has been used in a generic sense to refer not only to a person's affective, or evaluative, feelings about some object, but also to beliefs (cognitions) about the object as well as his behavioural intentions (conations) with respect to the object. Thus much attitude research was confusing in that what were taken to be measures of attitude were, in fact, often measures of belief or intentions.

Definitions

A belief is a probability judgement that links some object or concept to some attribute[1]. The content of the belief is defined by the object and attribute in question, and the strength of the belief is defined by the person's subjective probability that the object-attribute relationship exists, or is true.

An attitude is a bi-polar evaluative judgement of the object. It is essentially a subjective judgement that one likes or dislikes the object, that it is good or bad, that he feels favourable or unfavourable toward it[2].

An intention is a probability judgement that links the individual to some specific action. That is, it is the individual's belief that he will perform some behaviour. The content of the intention is defined by the behaviour in question, and the strength of the intention is defined by the person's subjective probability that he will, or will not, engage in the action in question. Behaviour is an observable action that is quantifiable on either a dichotomous or a continuous scale.

The Relations between Beliefs, Attitudes, Intentions and Behaviours

Figure 1 summarizes the relations between beliefs, attitudes, intentions, and behaviours with respect to a given object. It can be seen that a person holds many beliefs about any given object, that is, he associates that object with a number of different attributes. It has been found that knowledge of a person's beliefs about an object, and his evaluations of the associated attributes, allows an accurate prediction of his attitude towards the object. That is, a person's attitude toward any object is a function of his beliefs about that object weighted

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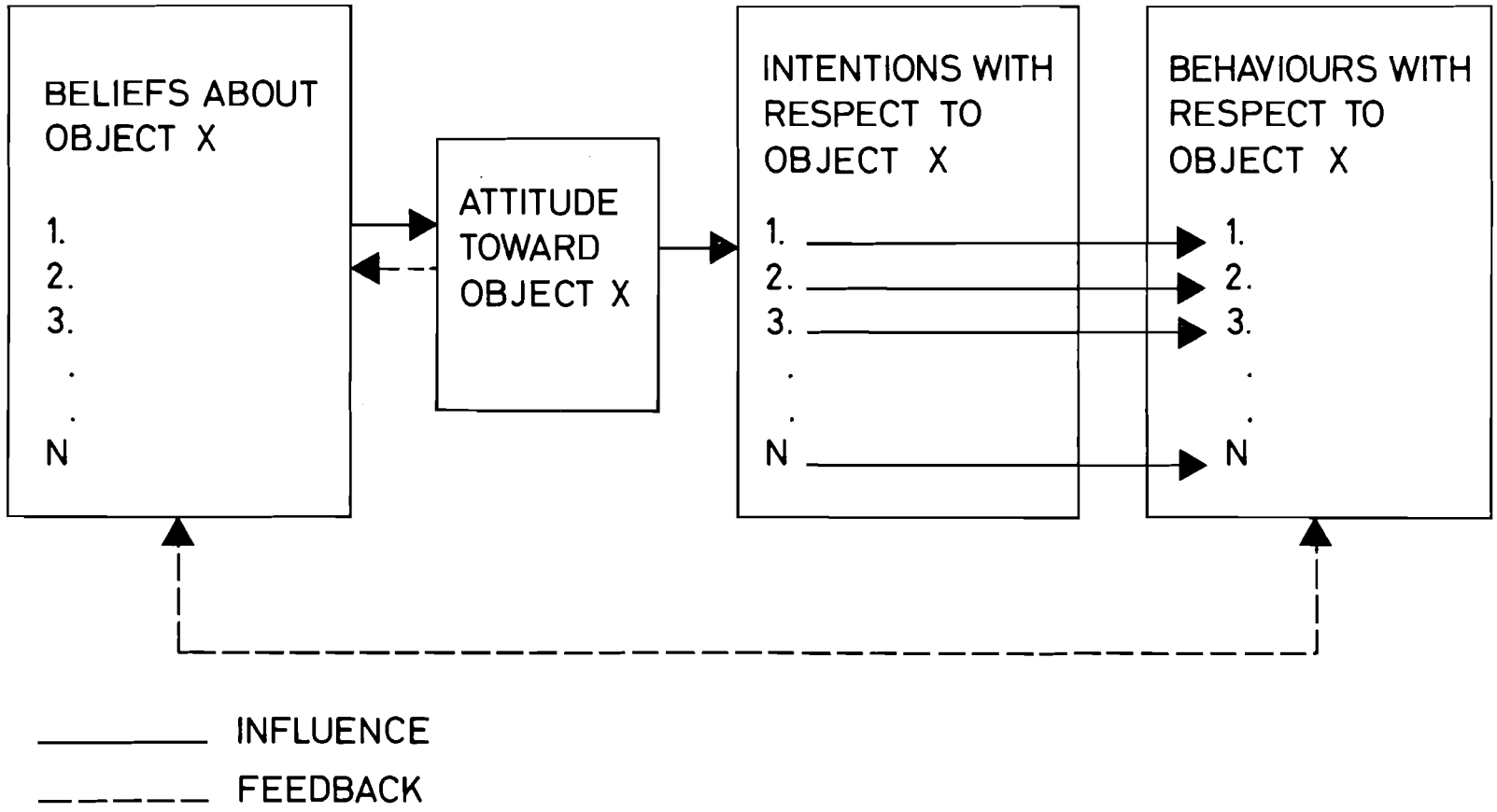
[1]The terms 'object' and 'attribute' are used in a generic sense and both terms may refer to any discriminable aspect of an individual's world. For example, one might believe that Automobile A (an object) is expensive (an attribute).

[2]The term 'object' is again used in a generic sense. One may have attitudes towards concepts, people, institutions, events, behaviours, outcomes, etc.



Schematic presentation of conceptual framework relating beliefs, attitudes, intentions, and behaviours with respect to a given object.

FIGURE 1

by these evaluations; however, it is the entire set of salient beliefs that determines the attitude and not any specific belief. Research on attention span, apprehension, and information processing suggests that an individual is capable of attending to or processing only five to nine items of information at any given time (Miller, 1956; Woodworth and Schlosberg, 1954; Mandler, 1967). Consistent with this finding, a person's attitude toward an object is likely to be determined by a relatively small number of salient beliefs.

Once an attitude has been formed, a person is predisposed (i.e., intends) to perform a pattern of behaviours with respect to the object. Once again, it must be noted that although his attitude does predispose him to perform a set of behaviours, it does not predispose him to perform any specific behaviour. Although it had previously been assumed that a person's attitude towards some object would influence some particular behaviour with respect to that object, it is now clear that attitudes towards an object may have little or no influence on any specific behaviour. Just as attitude is determined by the entire set of beliefs that a person holds, the attitude only serves to predispose the person to engage in a set of behaviours that, when taken together, are consistent with the attitude.

This is nothing more than a recognition of the fact that a person's attitude may be expressed in a variety of ways. For example, person A might express his liking for person X by inviting him to the theatre. However, individual B, with the same favourable attitude toward person X, might invite X to his home rather than to the theatre.

However, Figure 1 does not imply that there is no relationship between attitude towards an object and intentions to engage in various behaviours with respect to that object. Rather, it suggests that if one were interested in the totality of intentions a person held with respect to some object, knowledge of a person's attitude would be a useful predictor. That is, the more favourable the person's attitude, the more positive and the fewer negative behaviours he would intend to perform. In other words, if a person's attitude toward some object were to become more positive, one would expect an increase in the number of positive behaviours he intends to engage in with respect to that object. There is no guarantee, however, that it will increase the person's intention to engage in any particular behaviour. For example, increasing a person's attitude toward the theatre may increase his intention to attend the theatre more often but may not affect his intentions with respect to buying a season ticket.

Figure 1 also shows that a person's intention to engage in a specific behaviour with respect to an object is the primary determinant of that behaviour, i.e., the single best predictor of whether or not a person will engage in a particular behaviour is his intention to perform that behaviour. In contrast to the relations between beliefs and attitudes, and attitude and intentions, we do assume a one-to-one relation between intention and behaviour, barring outside interventions. This means that everything said about the attitude-intention relationship also applies to the attitude-behaviour relationship.

In summary, a person's attitude towards an object will not be related to specific behaviours with respect to the object but is related to the pattern of behaviours he will perform. In the case where we are interested in the totality of social response to an object, or technology, object attitudes assume a special importance[3].

Attitude Formation

While Figure 1 indicates that a person's attitude toward an object is some function of his or her beliefs about the object, we have not as yet considered the way in which these beliefs combine to yield an overall feeling of favourableness or unfavourableness toward the object, i.e., an attitude. It should be recalled, however, that each belief about an object links the object to some other object or attribute, which is positively, negatively, or neutrally valued. According to Fishbein's model, a person's attitude toward any object can be viewed as a weighted sum of his evaluations of the related attributes. The evaluation of the attributes contributes to the attitude towards the object in question in proportion to the strength of the belief that the object is characterised by that attribute. That is, the more certain one is that an object has a given attribute, the more the evaluation of that attribute contributes to the attitude toward the object.

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[3]Although a discussion of the determinants of specific behaviours is beyond the scope of the present paper, Fishbein (1967) and his associates (e.g., Fishbein and Ajzen, 1973, 1975) have developed a theory of intention and behaviour in which two major variables (i.e., attitudes toward performing the behaviour and subjective norms concerning the behaviour) are viewed as the immediate determinants of an intention to perform a given behaviour. Interested readers are referred to Fishbein and Ajzen, 1975, and Ajzen and Fishbein, 1973.

For the quantitatively-oriented, the above can be put into mathematical form as follows[4]:

$$A_o = \sum_{i}^{n} b_i e_i \qquad \text{Equation 1}$$

where A_o = the person's attitude towards object o.

b_i = the strength of belief i about object o; i.e., the subjective probability that o is related to some attribute i.

e_i = the subject's evaluation of attribute i.

n = the number of salient beliefs the subject holds about object o.

Note that Equation 1 is a general expression for an expectancy value model, and thus is compatible with the work of Rosenberg (1956), Edwards (1954) and others. That is, although Fishbein arrived at Equation 1 through a consideration of learning theory and conditioning mechanisms, very similar models have been generated by other investigators working from different theoretical perspectives. Although there are, in fact, some important theoretical and methodological differences between the various expectancy-value models, the models are more similar than dis-similar. For example, in the framework used here, Edwards' (1954) notion of subjective expected utility (SEU) is interpreted as an attitude toward a choice behaviour. That is, since SEU is a function of beliefs (i.e., subjective probabilities) that "selecting a given alternative" will lead to various outcomes, and the value (i.e., subjective utility) associated with each outcome, SEU can be viewed as the person's attitude toward the behaviour of selecting the alternative in question.

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[4]It has been argued (e.g., Hackman and Anderson, 1968) that an additional variable (an importance weighting) should be included in the expectancy-value model of Equation 1. However, subsequent investigations (L.R. Anderson, 1970; Kaplan and Fishbein, 1969; Wyer, 1970) have found that the additional variable tends to attenuate the predictive validity of the model.

EXPERIMENTAL DESIGN AND PROCEDURE

Considerable empirical evidence to support Equation 1 can be found throughout the attitude literature. For a review, see Fishbein and Ajzen, 1972 and 1975. This section will discuss the mechanics of experiments designed to test the model.

The first requirement is to elicit the attributes of the object in question. A variety of techniques have been mentioned in the literature; the most common is through an open-ended questionnaire given to a subset of the group to be studied (Fishbein, 1963; Fishbein and Raven, 1962). The modal salient beliefs of the group (i.e., those most frequently elicited) form a basis to construct a set of attributes that can be evaluated by the subjects. The attribute should be evaluated without regard to the specific object in question. For example, a salient belief about a person might be that he is tall. In this case, the attribute "tall" is evaluated. Note that one does not evaluate the belief that "person x is tall". Evaluations are normally made on a seven-place bi-polar scale which might range from "bad" (-3) to "good" (+3).

Belief statements are formed which link the attitude object to the various attributes. Beliefs are a matter of subjective probability, thus these judgements are made on a scale which has a probabilistic element, e.g., "John is tall", rated from "probably false" (-3) to "probably true" (+3). Note that, were attitudes toward other objects to be estimated at the same time, the evaluation of the attribute "tall" would remain constant. It would be only necessary to determine the degree of belief for each object, e.g., "Mary is tall".

The measure of attitude obtained from the model is then the sum of the salient eb products as as shown in Equation 1.

Test of Validity

To verify that $\sum$ eb indeed provides a measure of attitude, the subjects may be ranked in terms of their $\sum$ eb attitude scores and this rank-ordering compared with rank-orderings obtained from a direct measurement of attitude. Actually, any correlational procedure can be used to test the model.

One of the more convenient and reliable measuring instruments for direct attitude scaling is the semantic differential of Osgood (1952) and Osgood, Suci, and Tannenbaum (1957). The basis of this technique is the ascertion that the function of ordinary language is the communication of meaning; therefore ordinary language can be used to differentiate between concepts and thus measure their meaning. Extensive studies in 26 different cultures

have allowed the identification of three major dimensions which have proven to be the most important factors of semantic connotations. One of these dimensions is the evaluative dimension which is a direct measure of attitude. To measure attitude, the subject is presented with a series of seven-place bi-polar adjective scales. The end-points are defined by adjectives which have been shown to have evaluative connotations, e.g., good-bad, wise-foolish, harmful-beneficial. The subject is asked to rate the object by placing a check mark at the point on the scale which he feels best describes it. The attitude score is the sum of these ratings.

In summary, correlations between the $\sum \underline{eb}$ attitude scores and the direct attitude measurements from the semantic differential provide a test of the validity of the attitude measures obtained from the model.

AN APPLICATION TO NUCLEAR POWER

As noted previously the validity of the model has been demonstrated in areas such as racial attitudes, family planning, politics, and special experiments in laboratory settings. This paper explores the applicability of the model to attitudes toward technologies; nuclear power was selected as a case study of interest. Attitudes toward nuclear power, and the risks associated with nuclear power, were investigated.

The particular attributes to be used in formulating the questionnaire were developed primarily from previous research oriented toward identifying factors which influence the perception of technological risks or the technologies themselves (Otway, 1975; Otway, et al., 1975; Maderthaner, et al., 1976; Swaton, et al., 1976; Otway and Pahner, 1976; Pahner, 1976; Nowotny, 1976; Golant and Burton, 1969; Starr, 1969; Lowrance, 1976; Agrafiotis, de Larminat and Pagès, 1977). For example, in considering the attitude toward nuclear power, one of the attributes used was that of "can be mis-used in a destructive way". In the attitude toward nuclear power risks, a sample attribute used was, "likely to be fatal". The complete sets of attributes used for attitude toward nuclear power and nuclear power risks may be found in Tables I and III, respectively (see pages 12 and 16).

The Experiment

The attributes were used as the basis for a questionnaire, designed in accordance with the earlier description. For example, in order to obtain e_i of Equation 1 for the attitude toward nuclear power, subjects were asked to evaluate each of the twelve attributes in Table I on a seven-place scale (scored from -3 to +3), such as the following:

can be mis-used in a destructive way

bad ____:____:____:____:____:____:____ good

The respondents were then asked to indicate their beliefs that nuclear power is characterised by each of the attributes in Table I. For example, the statement

Nuclear power can be mis-used in a destructive way.

probably false ____:____:____:____:____:____:____ probably true

This seven-place scale is also scored from -3 to +3; these values are the b_i of Equation 1.

Direct measures of attitudes toward nuclear power, and the risks associated with nuclear power, were also obtained using the semantic differential. As described earlier, this allows comparison of the $\sum \underline{eb}$ values from Equation 1 with these direct measures.

The questionnaire was administered to a group of 30 people in the USA who were affiliated with a university institute engaged in energy-related research. Almost all had university degrees, 16 had experience in the nuclear energy field, 14 had had no nuclear-related experience. There were 21 males and 9 females; the average age was in the mid-40's. All Ss were presented with a 32 page booklet with the standard instructions for using the semantic differential as the first two pages (Osgood, et al., 1957, p. 82-4).

Results

Using Equation 1, two estimated attitude scores were computed for each of the 30 Ss; one of these scores was for the attitude toward nuclear power, the other for the attitude toward the risks associated with nuclear power. The results of the two attitude measurements will be discussed separately.

Nuclear Power

Since b and e could each range from -3 to +3, the possible range of estimated attitude scores was between -108 and +108. The actual range of estimated scores was between -50 and +41. Similarly, the possible range of scores for the direct attitude measurement by the semantic differential was between -21 and +21. (Eight adjective pairs, scored -3 to +3 were used; however, a subsequent factor analysis indicated that one set had not loaded on the evaluative dimension. Thus it was neglected in computing the scores.) The actual range of the direct attitude scores was -10 to +21. In support of the model (Equation 1), the Spearman rank

order coefficient between the estimated and direct attitude scores was 0.66 ($p < 0.001$, $N = 30$)[5].

The Risks Associated with Nuclear Power

Eleven attributes were used in the part of the questionnaire dealing with attitudes toward the risks associated with nuclear power. The possible range of estimated attitude scores was between -99 and +99; the actual range obtained was -56 to +14.

The possible range of scores for the direct (semantic differential) attitude measurement was -18 to +18 (two of the eight adjective pairs used were found by factor analysis not to have loaded on the evaluative dimension). The actual range of direct risk attitude scores was -15 to +11. The validity of the model (Equation 1) was again confirmed in that the Spearman rank order coefficient between the estimated and direct risk attitude scores was 0.76 ($p < 0.001$, $N = 30$)[6].

Discussion of Results

Given the validity of this application of the model, one may now examine in detail the cognitive structures underlying the formation of these attitudes. The model is so constructed that one can separately examine belief and evaluation. In addition, the absolute magnitude of the eb values for each attribute provide a measure of their respective importance (Fishbein and Ajzen, 1975). Absolute values are used since attributes can have high positive eb scores for one part of the sample and high negative eb scores for another. This could result in average eb scores

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[5]In addition $\sum_{i}^{n} b$ and $\sum_{i}^{n} e$ were correlated with the direct attitude measurements. The correlations were 0.22 (n.s.) and 0.39 ($p < 0.05$) respectively. This indicates that a better estimate of attitudes was made by using both b and e in the model than using either along as an indicator.

[6]The correlations between $\sum_{i}^{n} b$ and $\sum_{i}^{n} e$ and the direct risk attitude measurements were -0.55 ($p < 0.001$) and 0.49 ($p < 0.001$) respectively. The high correlation between $\sum b$ and the direct measurement is due to the uni-polar nature of a risk attitude measurement, i.e., all the attributes are evaluated negatively.

near zero. Such items, however, should not be neglected since they are important to both sub-groups and are instrumental in differentiating between various segments of the population. Importance is, therefore, retained by use of the absolute value of the eb terms[7].

Nuclear Power

In order to better understand the factors differentiating between people with favourable and unfavourable attitudes toward nuclear power, two sub-groups were formed from the total sample. Using the direct attitude measurement scores from the semantic differential as the criterion, the ten subjects with the highest scores formed the "pro" group and those with the ten lowest scores the "con" group. Table I presents comparisons of importance values and ranks for each attribute, for the total sample and each of the two sub-groups.

In general, the results for the total sample confirm what one might intuitively expect from a well educated group of subjects of high socio-economic status, many of whom were professionally experienced in energy research. The three most important determinants concern waste production, the possibility of destructive mis-use of the technology, and the question of catastrophic accidents affecting large numbers of people. In contrast, the next three determinants associate nuclear power with the positive attributes of providing good economic value, providing essential social benefits and the enhancement of the "quality of life". Note that, for the total sample, the risk aspects of nuclear power are more important attributes than are the potential benefits.

A different picture emerges when the two sub-groups are examined separately. In general, the "con" group, like the total sample, assign high importance to the risk items while the "pro" group view benefit-related attributes as most important. In the "con" group only one of the three benefit items important for the total sample appears in the first six items. Consistent with this, enhancing the "quality of life", sixth most important attribute for the total sample, is the least important attribute for the "con" group. In marked contrast, it is the second most important attribute for the "pro" group. Indeed, the three most important attributes for this group were all benefits; the next two most important attributes concern risks.

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[7]The algebraic average of the eb scores may be viewed as an indication of each attribute's contribution attitude.

TABLE I

IMPORTANCE OF ATTITUDE DETERMINANTS - NUCLEAR POWER

DETERMINANT	TOTAL SAMPLE		"PRO" GROUP		"CON" GROUP	
	Importance Rank	Average Importance $\overline{\|eb\|}$	Importance Rank	Average Importance $\overline{\|eb\|}$	Importance Rank	Average Importance $\overline{\|eb\|}$
creates noxious wastes	1	5.17	5	4.50	2	7.00
can be mis-used in a destructive way	2	5.03	4	5.50	3	6.10
can affect large numbers of people at the same time	3	5.00	10	3.20	1	7.10
provides good value for the money	4	4.47	1	7.00	8	2.80
provides benefits which are essential to society	5	4.27	3	5.80	4	4.30
enhances "quality of life"	6	3.70	2	6.70	12	1.50
consumes large quantities of natural resources	7	3.37	6.5	3.90	7	2.90
in the hands of big government or business	8	3.00	8	3.40	6	3.40
uses principles and processes which are difficult to conceptualize	9	2.77	9	3.40	9	2.00
presented a new and different mode of death	10	2.73	11	2.80	5	4.10
offers social benefits which are not highly visible	11	2.30	6.5	3.90	11	1.60
seldom seen or contacted in daily life	12	1.63	12	0.07	10	1.90

Analysis of Underlying Cognitive Structures

Table II presents the mean algebraic $\overline{eb}$ scores, the mean belief strengths ($\bar{b}_i$), and the mean evaluations ($\bar{e}_i$) of each attribute, for the "pro" and "con" groups. This Table allows the identification of those aspects of the cognitive structure which most clearly differentiate between the two groups. As indicated previously, algebraic values of the $\overline{eb}$ terms represent their contributions to the overall attitudes. For example, in Table II, the perceived relationship between nuclear power and "big government or business" contributes positively to the "pro" group's attitude, negatively to that of the "con" group. The reason for this difference can be better understood from looking at beliefs and evaluations. It may be seen that both groups strongly believe that nuclear power is in the hands of big government or business. However, while the "pro" group evaluates this attribute positively, the "con" group evaluates it negatively.

There were three items for which $\overline{eb}$ differences between the groups were statistically significant. These items were all related to the benefits of nuclear power: providing benefits essential to society, providing good economic value and enhancing the "quality of life". In all three cases both groups evaluated these attributes positively, although the "con" group valued enhancement of the "quality of life" significantly less than the "pro" group. However, for all three items the beliefs were the major factor contributing to these differences. More specifically, the "pro" group strongly believed that nuclear power offers these benefits, while the "con" group tended to be uncertain to somewhat negative[8].

There were no significant differences between the groups on the $\overline{eb}$ scores of any of the items related to risk. Both groups believed that nuclear power is characterised by the attributes of affecting large numbers of people, creating noxious wastes and possible destructive mis-use. Although both groups negatively evaluated these risk-related attributes, it is interesting that the "con" group's evaluations for two of them were significantly more negative. This indicates essential agreement among the groups with respect to nuclear power risks, but suggests that differing attitudes toward nuclear power may be primarily determined by strongly differing beliefs about its benefits[9].

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[8] A differential analysis was performed for the two groups composed of those respondents having experience in the nuclear energy field and those with no nuclear-related experience. No statistically significant differences were found.

[9] It is interesting to note that, in agreement with this result, many surveys on attitudes toward smoking have found that smokers and non-smokers tend to agree on the risks associated with smoking; significant differences are found in their perceptions of the benefits.

TABLE II

COGNITIVE STRUCTURE UNDERLYING ATTITUDES TOWARD NUCLEAR POWER

DETERMINANT	Average Attitude Contribution $\overline{eb}$		Average Belief Strength $\overline{b}$		Average Evaluation $\overline{e}$	
	"pro" group	"con" group	"pro" group	"con" group	"pro" group	"con" group
provides good value for the money	7.00	0.80 **	2.80	0.30 **	2.50	1.90
enhances "quality of life"	6.70	-0.50 **	2.60	-0.50 **	2.60	1.60 **
provides benefits which are essential to society	5.80	0.90 *	2.20	0.30 *	2.70	2.60
can be mis-used in a destructive way	-4.30	-5.70	2.00	2.20	-2.30	-2.30
uses principles and processes which are difficult to conceptualize	-3.40	-2.00	2.80	2.50	-1.20	-0.80
creates noxious wastes	-2.70	-6.60	1.80	2.30	-1.70	-2.50 *
can affect large numbers of people at the same time	-2.60	-5.30	1.90	2.60	-1.70	-2.70 **
consumes large quantities of natural resources	2.50	0.90	-1.00	-0.30	-2.10	-2.10
in the hands of big government or business	1.40	-2.20	2.90	2.60	0.40	-0.80
presented a new and different mode of death	-1.20	-4.10	1.50	2.40	-1.10	-1.50
offers social benefits which are not highly visible	-0.70	1.00	1.60	0.90	0.00	0.30
seldom seen or contacted in daily life	0.10	-1.50	1.20	2.30	0.10	-0.50

* difference significant at 0.05 level

** difference significant at 0.01 level

The Risks Associated with Nuclear Power

The results of the analysis based on attitudes toward nuclear power indicate that, for this sample, people for and against nuclear power did not differ significantly in their beliefs with respect to nuclear risks, although they did differ in their evaluation of some risk attributes. There has been much discussion about differences in risk perception and the contributing factors. In order to examine these differences in more detail, two groups were formed using the same procedure used in forming the "pro" and "con" groups. In this case, the semantic differential scores for the attitude towards the risks associated with nuclear power were used as the criterion. Here the ten people most favourable towards these risks are defined as the "risk" group and the ten people least favourable as the "risk averse" group. Note that the memberships in these two groups are not the same as in the "pro" and "con" groups. For example, some people were found to have a positive attitude toward nuclear power, but a negative attitude toward the associated risks.

Table III shows the importance of the risk-related attributes for the total sample, the "risk" group and the "risk averse" group. There it may be seen that, for the total sample, the most important determinant is that nuclear risks may affect large numbers of people. The next most important attribute is that of people being involuntarily exposed to these risks - that is, they have no choice as to whether or not they wish to enter the risk situation. The third-ranking attribute is that the risks involved are likely to have a fatal outcome; the fourth concerns the delayed effects of nuclear risks.

Passive exposure to nuclear power risks was found to be the fifth determinant. This item is distinctly different from involuntary exposure to the risk situation. For example, one might enter an airplane of lift voluntarily and thus accept voluntary participation in the risk situation. However, once inside the machine, one is essentially unable to affect the risk outcome through his skills or actions and may be said to be passively exposed to the subsequent risks. In contrast, the driver of an automobile is a voluntary participant who, because of this control over the automobile, is actively exposed to the risk.

These five determinants are also the most important for the "risk averse" group, although their order differs slightly. In contrast to the "risk averse" group, the importance values for the "risk" group tend to fall within a rather narrow range, indicating little differentiation in terms of attribute importance.

TABLE III

IMPORTANCE OF ATTITUDE DETERMINANTS - NUCLEAR POWER RISKS

DETERMINANT	TOTAL SAMPLE		"RISK" GROUP		"RISK AVERSE" GROUP	
	Importance Rank	Average Importance $\overline{\lvert eb \rvert}$	Importance Rank	Average Importance $\overline{\lvert eb \rvert}$	Importance Rank	Average Importance $\overline{\lvert eb \rvert}$
can affect large numbers of people at the same time	1	5.30	3	3.10	1	7.00
imposed upon people involuntarily	2	4.07	7.5	2.30	2	5.90
likely to be fatal	3	3.97	1.5	3.30	5	4.70
may take effect at a later time	4	3.83	4.5	3.00	3	5.60
people exposed to risks in a passive way	5	3.67	6	2.80	4	5.50
not scientifically established with certainty	6	3.20	9	2.10	6	3.60
determined by the actions of men and machines	7	2.67	1.5	3.30	8.5	2.70
people cannot imagine themselves exposed to these risks	8	2.37	7.5	2.30	7	3.10
not known to the average person with certainty	9	2.30	4.5	3.00	8.5	2.70
people have had no personal experience with these risks	10	1.47	11	1.10	10	1.70
determined by natural forces	11	1.40	10	1.50	11	0.70

Analysis of Underlying Cognitive Structures

Table IV presents the mean algebraic eb scores, the mean belief strengths (b_i) and the mean evaluations (e_i) for the "risk" and "risk averse" groups. Here we find that there were three items for which differences between algebraic eb scores were statistically significant.

The attributes concerning involuntary imposition of risks, passive exposure, and affecting large numbers of people contributed significantly more negatively to the attitudes of the "risk averse" group than to those of the "risk" group. It may be seen that these differences are primarily due to differences in beliefs. The "risk averse" group strongly believe that nuclear power risks are imposed on people involuntarily, and that people are passively exposed to these risks. The "risk" group, however, is significantly less certain of this. Although both groups are quite certain that large numbers of people can be affected, this belief is significantly stronger for the "risk averse" group. Consistent with earlier findings, the two groups also differentially evaluate this attribute. Both evaluations are negative, but the "risk averse" group significantly more so. No other attributes were differentially evaluated at a significant level.

These findings suggest, at least for this sample, that those who believe people are involuntarily exposed to nuclear power risk, in a passive way, also tend to judge the risks as being unacceptable.

SUMMARY AND CONCLUSIONS

There has been considerable speculation by both supporters and opponents of technological development about the determinants of the public response. This has been especially pronounced in the case of nuclear energy where these discussions have essentially remained at the level of speculation.

In this paper we have described a theoretical framework which indicates that attitudes toward an object create a predisposition to behave in a consistent manner with respect to that object and thus provide a useful indicator of the totality of response to that object. In this model, attitudes are seen to be a function of a relatively small number of salient beliefs which link the object to specific technical, psychological or social attributes. These beliefs, whose respective strengths are measured on a probabilistic scale, are each weighted by an evaluation of the attribute. The belief strengths, weighted by their evaluative aspects, are summed to determine the attitude score. In support of the model, these estimated attitude scores correlated highly ($r = 0.66$, $r = 0.76$) and significantly ($p < 0.001$) with direct, semantic differential, measures of attitude.

TABLE IV

COGNITIVE STRUCTURE UNDERLYING ATTITUDES TOWARD NUCLEAR POWER RISKS

DETERMINANT	Average Attitude Contribution $\overline{eb}$		Average Belief Strength $\overline{b}$		Average Evaluation $\overline{e}$	
	"risk" group	"risk averse" group	"risk" group	"risk averse" group	"risk" group	"risk averse" group
can affect large numbers of people at the same time	-1.90	-7.00 **	1.60	2.80 *	-1.40	-2.50 *
may take effect at a later time	-2.20	-5.60	1.60	2.30	-1.20	-2.20
people exposed to risks in a passive way	1.80	-5.50 **	0.40	2.10 **	1.50	-2.10
imposed upon people involuntarily	-0.50	-5.50 **	0.30	2.00 *	-1.50	-2.40
likely to be fatal	0.30	-3.10	-0.70	0.80	-1.90	-2.60
not known to the average person with certainty	-2.80	-2.70	2.30	2.30	-1.20	-1.10
people have had no personal experience with these risks	-1.10	-1.70	2.40	2.70	-0.40	-0.60
people cannot imagine themselves exposed to these risks	0.90	-0.90	-0.20	-0.10	-0.90	-0.20
determined by natural forces	1.50	0.70	-1.90	-0.60	-0.80	-0.40
not scientifically established with certainty	-0.40	0.00	0.00	0.70	-1.50	-2.00
determined by the actions of men and machines	1.10	-0.70	2.40	2.50	0.40	-0.30

* difference significant at 0.05 level

** difference significant at 0.01 level

It should be noted, however, that the particular group used in this study was not representative of the general population. It was composed largely of professional people employed at a university institute engaged in energy research. Thus one should not assume that the results can be generalized to other populations. For example, the same set of underlying beliefs would not necessarily have the same relevance in another group. This does not detract from the demonstration of the utility of the model in this area of investigation.

Perhaps more important, it was shown that even with small sample sizes a detailed analysis of the cognitive structures underlying attitudes toward nuclear power and nuclear power risks could identify the factors statistically significant in differentiating between people with favourable and unfavourable attitudes. For example, the sub-groups "pro" and "con" with respect to nuclear power did not differ significantly on their beliefs about risk-related attributes; the major difference in the attitudes of these groups toward nuclear power was accounted for by differing beliefs about its benefits. Consistent with this finding, the benefit-related attributes were most important for the "pro" group while risk-related attributes were most important for the "con" group.

With respect to attitudes toward nuclear power risk, the main factors distinguishing between the "risk" and the "risk averse" groups were the beliefs that people are exposed to these risks involuntarily and in a passive way. People strongly holding these beliefs tended to view the risks as being unacceptable.

It has often been assumed that much of the social conflict surrounding technologies such as nuclear power has been due to different perceptions. One advantage of the approach used in this paper is that it allows the objective measurement and description of these perceptions through identification of the attributes used by different groups to characterise the technology. Knowing the ways in which people differentially characterise the same technology provides useful information for the decision maker. As an example, it becomes possible to see if potential changes in the technology are reflected in the cognitive structure which underlies the overall response.

The measuring instrument used in this study is being revised by eliminating the separate section on risk attitudes and providing more detailed risk and benefit attributes in the object attitude area; it is also being extended to apply to other types of energy systems. It is planned to replicate this study with a larger sample including many different sub-groups which would allow inter-group comparisons to gain further insights into the cognitive structures underlying attitude formation. Pending the results of the replication, arrangements are being made to allow the use of the measuring instrument for cross-cultural comparisons.

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