A DECISION ANALYST'S REGARDS ON THE NUCLEAR DEBATE.

FROM A NIGHTMARE TO A DAYDREAM

D. LECLERCQ

Département de Philosophie de
l'homme de sciences.

This paper is divided into four major parts. In the first one, the problem will be stated in decision analysis technical words (underlined). In the second one, this decision will be situated in the more general context of society. In the third part, a concrete solution will be proposed. In the last one, discussion and references will be provided.

I. The decision analysis model and terminology.

The predicted (and predictable) lack of current sources of energy faces our generation with a two sided question.

A. We must state the problem itself on the right basis : should we conceive new sources of energy, new ways of life, or both? In any case, we are urged to be creative.

B. We are faced with chosing among complex possible courses of actions. Here we are urged to be democratic, coherent and responsible.

The first operation in stating such a decision problem consists in identifying the (physical or psychological) outcomes (or needs), that is the desirable consequences of actions. Here is a (short) list of examples :

C_1 - dispose of energy in peak period (winter) of for peak activities (steel working)...

C_2 - go on driving cars

C_3 - preserve nature and world resources for future

C_4 - preserve people's health and security

C_5 - have a democratic control on collective decisions

etc..

In the present case, these consequences present the following caracteristics :

a) They are numerous (much more than the five examples hereover)

b) they belong to various dimensions (ex : c_1 and C_5) ; they have multidimension-

nal attributes
c) different individuals may desagree upon their interest, their importance
d) into a given dimension, they may   differ in importance for a gi-
   ven individual.

By listing the various (desirable or unwanted) consequences of the deci-
sion, we constitute a tree of consequences, each terminal branch belonging to
a more larger   domain.

By assessing to each consequence a utility value (an importance expressed on a
subjective scale), we constitue a value tree (see third operation).

The second operation, in stating this decision problem, consists in lis-
ting the possible acts, or available courses of action. Here are a few examples.
a_1 - Reduce drastically petrol consummation for cars!
a_2 - Build nuclear centrals.
a_3 - Build numerous solar energy transformers spread over the country.
a_4 - Set up chains of geant sattellites that could transform solar energy.
a_5 - Combine a_1, a_2 and a_3
a_6 - Combine a_2 and a_4
etc.

Actually, those courses of action should be far more explicit in order
to constitute alternative plans, (a set of interdependent possible acts), which
will present the following caracteristics.

a) They are numerous, depending on the creativity of proponents or on the adap-
   tability of people (to new ways of life).
b) They have different effects on the consequences (for instance plan a1 con-
   tradicts consequence c2, etc).

The third operation in stating this decision problem consists in the
allocation of a utility (that is an index of relative importance) to each con-
sequence. Conventionnaly, positive values of utilities could refer to attractive
consequences and negative values to consequences the individual tries to avoid.
A zero value of utility could indicate indifference. This is not a crucial point
since all utilities can be transformed with a linear function into others. If
many individuals are involved, and if they are assumed to have equal power,
the mean utility of a consequence would be

$$\overline{U}_c = \sum_i^{ni} U_{ic}/ni \qquad \text{where } i \equiv \text{individuals (up to ni)} \atop c \equiv \text{consequences(up to nc)}$$

The fourth operation in stating this decision problem consists in jud-
ging the effect of each possible plan, or course of action (up to na) on each
desirable consequence. These effects could be expressed by two parameters :
their degree of importance[b] and their probability (P). Those two values may
be combined for computing expected effect (E):

$$E_{aci} = D_{aci} \times P_{aci}$$

where E_{aci} = Effect of Action a on Consequence for Individual i. It must be noted that often, P_{aci} are very difficult to estimate.
The <u>resulting utility</u> (RU) of a course of action for an individual could be expressed as

$$RU_{ai} = \sum_{c=1}^{nc} E_{aci} \times U_{ci}$$

If the individuals are assumed to have the same power, the same scales of utilities and the same list of A and C , than it is possible to compute $\sum_{i}^{ni} RU_a$ for each course of action.

The fifth (and last) operation in stating this decision problem consist in defining the rules that will guide choice behavior. Here are a few well known rules :

r_1 – Choose the A that maximises $\sum RU_a$, by fixing the P of negative consequences to 0 and the P of positive consequences to 1. This optimist rule is known as the <u>maximax</u> strategy.

r_2 – Choose the A that maximises $\sum RU_a$ by fixing the P of negative consequences to 1 and the P positive consequences to 0. This pessimist rule, known as the <u>maximin</u> strategy, will provide the less negative state of affairs in a catastrophic situation (the desaster case).

r_3 – Choose the A that maximises $\sum RU_a$ with each consequence given a same probability (1/nc). This rule of "ignorance" is known as the principle of unsufficient reason or equiprobability (LAPLACE criterion).

r_4 – Choose the A that maximises $\sum RU_a$ with a given (constant) value of P^- ($P^- > 0$) for the negative consequences and with complementary value of $P+$ for the positive consequences. This rule, mixing optimism and pessimism regardless to real state of the world is known as the HURWICZ criterion.

r_5 – Choose the A that maximises $\sum RU$, each c having its'own probability P_{ac}. This rational rule, known as the Expected Subjective Utility (ESU) criterion has been axiomatised by VON NEUMANN and MORGENSTERN (1947).

r_6 – Various other rules can be conceived ; SAVAGE'S minimax regret interion, COOMBS'preference of risk variances theory (unfolding technique), ATKINSON'S theory on preference of risks are, among others, possible rules.

Whatever will be the choosen rule, it must be conciously and clearly stated to all parts.

II. The difficulties of a concrete solution : the nightmare

Even if the nuclear issue had concerned only one individual, some problems would have arised :
- how should be agregated utilities from various dimensions (ethics, politics, economics, financial, health,...) ?
- how could he alone create alternative solutions that encounter so many needs, such technical points?
- how could he, alone, imagine the so numerous and hidden consequences of all courses of actions ?

Since the nuclear issue is a public concern, strengh of collective res-sources will be able to solve some of the points hereover. Unfortunately, the social aspect of the debate arises other problems:
- how to agregate utilities coming from various persons ?
- who should make the decisions, how and when ?
- who should give the advises, how and when ?
- who should provide the basic informations (probability estimates, co sts pre-visions...), how and when ?
- who should provide alternative solutions to cope with the situation, how and when ?

At present time, danger is great to see the problem answered before it had been fully exposed or stated, creating an "already established state of affairs" and avoiding a clear democratic process. The alternative to this shortening will be sophisticated as far as many objectives are pursued.

The goal is not limited to solving this particular (and important) problem, but extends to creating new habits and democratic decision processes that could deeply change the society in the long run. That type of new skills could enable future generation to avoid wars, inequalities between nations, foolish pollution of earth, and the like, that is major (negative) issues in human affairs.

The following project is deeply inspired by an on-going work by Ward EDWARDS with the Los Angeles Board of Education, faced with the legual pressure of mixing white and black students on the one hand and with the actually segregated situation on the other hand.

Pros [1] and Cons [2] claim for different solutions, so that finding a satisfaying solution appeared to the board as a nightmare : no one could satisfy each tendancy At present time, a decision analysis has been undertaken. It's success may not yet been predicted with certainty, but it is so far engaged, that it appear like a day dream, from the point of view of democracy .

----

[1] Various mouvements for integration of coloured people, espacially in schools.

[2] Committees like BEST (for better education) or BUSTOP (stop "bussing").

In order to give life fo the following project, we shall present it as if
it had already happened. Time will be shortened and difficulties of all
sorts skipp ed, while we do not neglect them : only the outlines will be
mentioned. This paper does not pretend to be a technical one, but merely
to suggest admissible scenarios.

III. Ten steps for a daydream

Things really started in this day of 1979 when the government created
the Permanent Commission of Energy constituted by twenty politicians
representative of the parlement structure. Those "twenties" as they were
rapidly called had one ye ar to answer the nuclear contest in a democratic
way. Since a lot of debates had already happene d in the previos years,
and a lot of "Commitees of Wises" constituted, only few people did mention
this new commitee at the moment. Meanwhile, inside of the group, politi-
cians accepted to have a decision analyst advise them. They were first
surprised to hear him suggest they should only make a politician job,
while scientists would make their own and the public will do it's one.

Actually, the twenties had to list   aspects of life than could
be affected by any energy politic. Environnement, health, economics and
a few other domains constituted the main branches . of a "tree" of effects
(each particular effect appearing as a branch of those large concepts).
The resulting 87 branches tree was presented by the decision analyst to
Pros and Cons groups that suggested few suppressions but a lot of additions
(22 in total). After repeated revisions, the twenties, Pros and Cons agreed
on 103 branches.

In the second step, the twenties had to attribute individual weights of im-
portance, the so called W values) for each of the 103 aspects. The deci-
sion analyst helped in this psychological scaling and in computing derived
indexes, especially the mean W value ($\overline{W}$) for each aspect. The result was
named "a valued tree", a "tree of values", and ,more often, "a value tree".

Meanwhile, large information about the whole procedure was carried out
by newspapers, radio and television (step 3). So, everybody was aware of
the existence of the 103 branches and could, as the twenties urged, prepare
a "plan of energy" according to those needs. Anyone, group or individual,
had six monthes for application of their plan, that is for achieving step 4.

A surprising result of the communication of the twenty names and the un-
valued tree (step 3) was the interest among people for the relative importan-
ces (W) politicians will give to each aspects. Some of the twenties wanted
to have their weighting published, whereas other were reluctant. In face of
the public reaction, it appeard to everybody that publicity of the values
had become unavoidable. The twenties had only three monthes to give them,
and during this period were continuo usly questionned and challenged, at
television debates, or by newspapers, about their opinion. The definitive
list of consequences was itself questionned and the group had to accept
four more branches.

A problematic question appeared to be the constitution of the Experts Com-
mitee. In order to have a symetric situation, the twenties and the de-
cision analyst proposed a well balanced list of twenty experts. But as
soon as this list was published, protests arised from various groups.
From public pressure, it turned out to be a 32 group of experts regardless
to the complains of the decision analyst that stressed the increasing dif-
ficulty of the whole operation. As this fifth step happened to take 7
monthes of public debate(it appeared lateron that these were not really
lost monthes, especially from the point of view of democracy and the dis-
cussion of what exactly was an expert), the dead line for sbmitting plans
was reported three monthes later.

During the 9 monthes, 89 plans and thousands of letters were sent to a
work group constituted of 5 members from "the 20" 5 from "the 32" and 5
from the decision analyst's team. Letters were answered, 62 plans were
returned for improvements, and, at the end, 47 recievable plans were taken
into consideration. Some were already well known by the public whereas
quite n ew ideas were exposed in others. One more time, the decision ana-
lyst programmed sequence was contradicted by public opinion. People wanted
to know the submitted 47 plans before experts handle them.

Newspapers did a very smart job (step 6) in presenting, in synoptical man-
ners, summaries of those havy works. Experts agreed that the procedure did
permit to obtain divergent combiningof the possibilities and definitely in-
teressant plans. This new amount of information was not only faremore grea-
ter than the first one (the value tree) but it appeared to be also much more
complicated for the average man to handle it. From this respect, it was
indicative that the two newspapers that had engaged a large survey to know
public opinion about the value tree (public W_s), did not dared to do the
same for the evaluation of the various plans.

IV. The impossible eighth step

Seventh and eighth steps were in the experts'hands : assess the effect of
each plan (47) on each aspect (107). This work had been divided into two
consecutive parts : assess the conditional effects (given an event) ; then
assess the probabilities of the events. The seventh step worked smart.
The experts desagreed -they always do- on a great number of points, but,
after successive revisions and accepting equality of power (one man = one
power), they reached a (difficult) consensus. The eighth step could hardly
start : the experts had their personnal probabilities and, tis time, did
not agree at all in accepting an average or any compromise. Probability
itself was questionned. Experts refused to discuss further, leaved the
group, meanwhile   others decided to have a theoretical conference on
probabilities, subjective probabilities and computer simulation of desas-
ters. Work was interrupted : no one could fix any date on the calendar and
the whole experience looked as a dead-end.

But, since the debate had alre ady become angry against experts and wanted ex-
planations. The first televised debate that followed marked a turning point
in the whole process. Urged by questions regarding the way he had found out
"his" probabilities, one of the most famous experts happend to answer that
the average man could not understand and that this was a too complicated

matter to be exposed during a T.V. shedule. The end of the emission was
concerned, not by the nuclear problem itself, but by the role scientists
are playing in our world, taking decisions for people, considering others as
children. It was declared by representatifs of the public opinion that people
can understand, wants to and challenge the media to help them to reach the
point (1). The following days, all the media repeated this message and
attacked the experts so th at the government imposed them to meet again and
to find a solution to public demand for transparence.

After a while, "the 32" group (helped again by the decision analyst) proposed to
engage a large information process and in the same time, to deepen, in their
own group, the justifying of their own assessment : each value should be
accompanied by it's underlying evidences.

Faced with such a good will, government allowed the group a few weeks more
to reach a conclusion.

It appeared that the increase of clarity helped experts to reduce the number
of points of disagreement so that, if contested values remained, the group
did not explose as it did previously. It must be noticed that those were
the same 32 experts, regardless to the general public demand of changing
the "offensant" one. Jurists and governement considered that the experts do
not belong to the same category as politicians ; since experts do not really
make decisions, they had not to be representative of population.

Even the decision analyst could not have "the 32" agree on all probabilities,
so he suggested to consider degrees of pessimism /optimism in assessing
the probabilites. In scaling this new dimensions, views came a least a little closer
a little closer, and closer again after a public controversy of
the principles, values and evidences for the numeric values.

The decision analyst's team then showed various results of computation to
"the 20 group" (the politicians). The 47 plans were ranked in five different
orders (there were five degrees in "optimism-pessimism" assessment of probabi-
lities). From a raw analysis of the data, it appeared clearly that 7 plans
were highly over the others, in respect to their cost as well as to their
efficiency and their garantees for safety (2).

During a seminary with the 32 experts, the suggestion (from the politicians
group) of mixing some parts of the 7 plans was at first time rejected. But a
politician's declaration was emphasised by various social groups, so that
the governement invited the experts to make possible mixings of the seven
plans, that is, to play with, in order to just see the results. The public
was supposed to be not aware of this game. Nevertheless,   by mix-
ing some aspects of the seven plans, three new ones revealed to be of far
higher interest than the basic ones. So the "players" could not keep from
announcing it.

---

(1) It was even suggested to use some football meeting transmission times,
so one can imagine how intense was the affective reaction.

(2) The rule "maximisation of the subjective expected utility"(S.E.U.) had
been adopted.

V. An endlesse daydream or an endlesse nightmare ?

At present time, some groups want a decision made by an individual (pre-
sident, prime minister), but a large majority claims that the democratic pro-
cess should be followed up to the end. A member of parliament expressed the
opinion that those two years had been waste of time for everybody. Results
from a survey undertaken by a university contradict him. A faculty depart-
ment of social sciences had measured knowledge, attitudes and political involvment
of representative large samples of the population. Since they have repeated
the measure two years later, comparisons were available.

Gains were surprisingly high on the three scales. Importance of newspapers,
television and radio arised strongly from the data. The most surprising
result was a kind of transfert : a lot of people feeled confident in them-
selves as to face other major problems it that way. During the few past
monthes, three members (from 52) had to be replaced. Some claimed that
they should not be replaced, but others argued that it will be a normal si-
tuation and that a rule should describe clearly how to have the groups
changing periodically.

The problem is not yet solved, but fewer and fewer, people think it will
not be. Yesterday the decision analyst published a comment on the whole
think. We reproduce it hereafter.

VI. To will ... perchance to win

Those five words were the title (1) of the decision analyst's paper. He
argued that he himself often had doubted about the feasability of the
whole operation, and is still doubting. But the reached point seemed to
him unexpected and this result could, on his opinion, be attributed to
four dimension of human beings. Here are samples of his paper :

> "As living being, man is willing and can mobilise energy.
> As human being, man uses his kwowledge and intelligence.
> As social being, man can pay attention others and to the future.
> As political being, man can imagine and realise democratic ways
> for decision making".

Later one, he shown, in a drawing, how those resources interact with each
other to meet conditions necessary for solving the present problem:

> "Courage & intelligence --------> technollgical creativity needed for
> conceiving plans.
> Intelligence & democracy ------> political crativity needed for fin-
> ding new political behaviors, new
> institutions.
> Sense of future & democracy ----> permanent information of public
> (including the scholar facet of
> education).
> Democracy & courage -----------> individual responsability (of po-
> liticians faced to public opinion,
> of groups making plans, of experts
> between themselves)

(1) They were inspired by Shakespeare. Maybe he was as depressive as Hamlet was."

At the end, he pointed out four key principles.

"1. Principle of separating the powers : decision makers (politicians), planners, evaluators (experts).
2. Principle of clarity in the decision rules.
3. Principle of publicity for values, plans, experts judgments, etc...
4. Principle of permanent revising of the process, with recurrent loops".

In a more technical part, he listed the steps :

"1. Construction of the value tree by politicians.
2. Weighting of the branches (utilities).
3. Results of steps 1 and 2 are published.
4. Build up plans.
5. Constitue the group of experts.
6. Publish plans.
7. Assess the degrees in which plans affect consequences.
8. Assess probabilities of effects of plans.
9. Publish results of steps 7 and 8.
10. Revise the whole process and, finally, make a decision".

VII. To dream ... perchance to live

The speculative aspect of the present paper can be counterbalanced by already undertook partial researches connected to the field.

For instance, in Laxenburg (Austria), the International Institute for Applied System Analysis (I.I.A.S.A.) has recently published works made by P. PAHNER (1976), R. MADERTHANER and others (1976), H. OTWAY and W. EDWARDS (1977).

The Commitee for Future Oriented Research (Stockholm, Sweden) has published reports on the Risk Project (L. SJOBERG, 1977).

The Sixth Research Conference on Subjective Probability, Utility and Decision Making, in WARSAW (Poland) recieved contribution in the field by psychologists like M. ZAUS and D. WENDT (1977), H. OTWAY and M. FISHBEIN (1977), W. EDWARDS (1977).

At the end, we would stress the point that decision making and democracy are first behavioral problems, so they must be "behaved", experienced.

The above kind of scenario is very likely to happen in future (for coming years or decades or centuries). What would really be smart is that it could happen to us, when we are still alive. Upon who and what does it depend ?

References

EDWARDS W. : Lecture on a decision analysis problem, Sixth R.C.S.P.U.D.M. (1),
          Warsaw, september 1977.

MADERTHANER R., PAHNER P., GUTTMANN G., OTWAY H. : Perception of technological
          risks : the effect of confrontation I.I.A.S.A. (2), june 1976.

OTWAY H. and EDWARDS W. : Application of a simple multiattribute rating
          technique to evaluation of nuclear wastes disposal sites :
          a demonstration, I.I.A.S.A., june 1977.

OTWAY H. and FISHBEIN M. : Public attitudes and decision making, Background
          Paper for the Working Group on Acceptable Risk and New Technology
          at the Sixth R.C.S.P.U.D.M., Warsaw, september 1977.

PAHNER P. : A psychological perspective of the nuclear energy controversy,
          I.I.A.S.A., august 1976.

SJOBERG L. : Summaries of the first fifteen reports of the risk project,
          Commitee for Future Oriented Research, Stockholm, report 14,
          august 1977.

ZAUSS M. and WENDT D. : Some problems in the design and assessment of hierar-
          chical goal structures in applied multi-attribute utility analysis,
          Sixth R.C.S.P.U.D.M., Warsaw, september 1977.

(1) Research Conference on Subjective Probability, Utility and Decision Making.

(2) International Institute for Applied Systems Analysis, 2361 LAXENBURG.