

SOCIAL ASPECTS OF THE NUCLEAR POWER CONTROVERSY

Helga Nowotny*

April 1976

Research Memoranda are interim reports on research being conducted by the International Institute for Applied Systems Analysis, and as such receive only limited scientific review. Views or opinions contained herein do not necessarily represent those of the Institute or of the National Member Organizations supporting the Institute.

*European Centre for Social Welfare Training and Research and the Joint IAEA/IIASA Research Project, International Atomic Energy Agency, P.O. Box 590, A-1011 Vienna, Austria.

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 responses to them, may be considered in decision-making. A conceptual framework is being used for risk assessment studies which includes in addition to the consideration of physical risks, the perception of risk situations and the resulting psychological and sociological levels of risk.

This paper deals with the sociological aspects of the controversy surrounding the introduction of nuclear power plants.

ABSTRACT

The responses to the introduction of nuclear power are examined and the underlying processes interpreted from a sociological viewpoint. The social dynamics of "para-scientific" controversies are reviewed; the nuclear power controversy is viewed from this perspective. Social movements for greater participation in the decision-making process are discussed and the role of the "scientist-activist" is developed. The differing time perspectives emerging in the nuclear controversy are reviewed.

Social Aspects
of the
Nuclear Power Controversy¹

Helga Nowotny²

I. Introduction

To many scientists engaged in nuclear power development, societal response, especially in the form of opposition, has come as a surprise. Was the large scale, commercial exploitation, the harnessing of this form of energy, not a great feat that the pioneers of nuclear development had hardly dared to dream about? And even if certain risks associated with the development of any kind of technology were present, were they not scrutinized with the greatest meticulous care? Were not all means deployed in order to foresee and minimize possible risks connected with the operation of power plants? Finally, even if risks remained, had not mankind been ready time and again before to accept them consciously in small-scale societies as well as in the history of industrialization, because the potential gains (economic or otherwise) seemed to make it worthwhile to engage in these dangerous pursuits? (1) Was the opposition merely due to a small fringe of society, to those who, steeped in traditional beliefs and traditional ways of life, were likely to oppose any kind of large-scale technological development? Or was it a small fringe of people, hypersensitive to potential dangers, who chose to carry around with them associations and mental images that may have befitted opponents of nuclear armament, but not the peaceful exploitation of nuclear energy? Or worse, was it environmentalists, eco-cracks, gone astray in leaving the golden middle road that promised access to a new and cheap energy source, who chose, with an incomprehensible obstinacy, the bleak alternative of 'having the lights go out' rather than agree to further large-scale exploitation of nuclear power?

¹The views expressed in this paper are those of the author, and do not necessarily reflect those of the Project Sponsors.

²European Centre for Social Welfare Training and Research and the Joint IAEA/IIASA Research Project, International Atomic Energy Agency, P.O. Box 590, A-1011 Vienna, Austria.

This impressionistic way of passing over some of the more common interpretations of societal response to nuclear power leaves us at best with a partial and incomplete picture.

The recent programme of the Joint IAEA/IIASA Research Project has been described by Otway and Pahner (2). Haefele has been especially concerned with what he called "the embedding into the sociosphere". I wish to focus in this paper on a task which can perhaps be interpreted as complementary, namely the embedding of some social considerations into the technosphere. An analysis of the social aspects of the nuclear power controversy strongly suggests that these wider considerations have to be taken into account if a meaningful dialogue is to be initiated.

In the analysis which follows, I will therefore NOT deal with the arguments that have been presented pro and con nuclear energy per se, but rather concentrate on a sociological interpretation of the underlying processes. In a recently published article (3) Hans Bethe has spelled out in clear and easily understandable language why nuclear power is both safe and necessary. To a newcomer in the debate, his arguments may appear sensible and convincing. One could however easily imagine a "counter-article" starting from entirely different premises and leading to a diametrically opposed set of conclusions. This strongly suggests that opponents and promoters of nuclear energy base their arguments on different assumptions, do not use the same language, attach different weights to evidence that is presented - in short, they literally see the world differently. Thus is the nature of a controversy.

Working one's way through the arguments that have been presented on both sides in the course of the debate, one sometimes has the feeling of being faced with one of the pictures of optical illusion that psychologists are fond of constructing. Depending on how one looks at the picture, the features of a beautiful girl appear or conversely, that of an old lady. On other pictures one may choose between a hare or a landscape; a goblet or two figures. What these pictures represent is genuine ambiguity. The human brain, unaccustomed to being given ambiguous information, responds in a rather unique way (4): if it can truly not be decided how to interpret the picture, it alternates between two possible interpretations. It decides on one, only to abandon it shortly afterwards in order to adopt the other possible interpretation.

Such options are not open to society. Given conflicting interpretations of safety and potential hazards connected with the use of nuclear energy, of economic necessities which either for its large-scale development or not, divergence of interests emerge in the course of the debate which call for an analysis of the possible roots underlying the conflict.

A further clarification may be necessary:

The nuclear power controversy is an ongoing public debate on a number of issues, such as safety standards, health hazards, economic rentability, risks connected with accidents, etc., which are controversial in the sense that conflicting interpretations of assumptions, facts, theories, and likely consequences of nuclear development are given by those who promote and those who oppose nuclear power. In the course of these controversies, a body of 'counter-knowledge' and 'counter-expertise' is created which serves as an important input, both scientifically and ideologically, on the level of social action.

Public opposition to nuclear power takes the form of concrete actions, either directly related to a local conflict, such as may arise spontaneously after the announcement of a plan to construct a nuclear reactor in a community, or, on a more permanent basis, action consisting of the formation of citizens and other groups which actively press for certain demands, such as a ban on further nuclear development, or the adoption and regulation of certain procedures and standards. On the theoretical and empirical grounds it is advisable to distinguish between these two phenomena, although it is important to see the links existing between them. Every instance of local opposition feeds back into the larger movement and is supported by it in various ways. One can therefore say that local opposition depends on the larger movement, just as the movement, in order to build up its case, depends on instances of local opposition. This holds for tactics, which are often transmitted to other groups and even from country to country, overlap in membership, coverage in the movement literature just as much as for public consciousness and the movement's ideology which, once it has been generated, must be sustained.

Certain individuals and groups, environmental groups as well as politically organized groups, provide an important link between these two levels. They can be viewed as manifestations of a larger social movement, which is a form of non-institutionalized, collective behaviour oriented towards the alleviation of perceived grievances and based on certain social demands.

The paper consists essentially of two parts. The first part is devoted to an examination of the significance of controversies in general and draws attention to their sociologically relevant features. In chapter V the notion of "para-scientific controversy" is introduced. It is suggested that the opposition against nuclear power is partly dependent on an ongoing controversy among experts. The second part examines public opposition with a brief coverage of local action and a more detailed attempt to explain the more permanent forms of opposition. This section, which interprets public opposition as part of a larger social movement, is still hypothetical and in need of further empirical elaboration, especially if an attempt is to be made to evaluate its chances for success or failure.

II. Institutionalized and Non-Institutionalized Controversies

Controversies signify DISAGREEMENT. They are a normal feature of our lives and thinking and form an integral part in arriving at a consensual view of the world surrounding us. In science, as in politics, disagreement is essential for the growth of knowledge as well as for advancing what is usually called the commonwealth (the common good).

"Controversies and politics", one might say, paraphrasing Lenin, "are both means for moving from one historical stage to another". They contain mechanisms for checking claims made by those who produce different knowledge or alternative political visions and demands. They allow us, in rare moments, to choose between rivalling theories or rivalling world views or courses of collective action. Knowledge finds itself opposed to other knowledge in a way that really matters, i.e., it is seen as having direct consequences for further theoretical developments and/or action. In science, we can distinguish at least four factors accounting for the emergence of controversies, which are not mutually exclusive:

- there is uneven development in the normal growth of scientific knowledge leading to heterogeneity in theoretical concepts, methods, and observational language which have to be adjusted from time to time;
- the production of new knowledge means essentially that perception is extended into new contexts and forms which need to be communicated to those who do not yet share this new knowledge;
- knowledge is produced in order to be used and thus may be linked to serve different ends;

- once cognitive disagreement is openly carried out, a process of social polarization tends to set in as well (5).

In theory at least, science has developed a set of rules and procedures by which controversies can be carried out in a more or less orderly fashion, leading eventually to their settlement - which may consist of victory or defeat, likewise problems or opponents may die out.

In practice, scientists do not always adhere to these rules and procedures. Even if they do not abide by them, they nevertheless believe in their validity, thus crediting the scientific method and rational discourse with the legitimacy necessary to ensure its proper functioning. To engage in a scientific argument as distinct from a 'non-scientific' one means essentially that opponents are united in believing that a rational mode of discourse exists which eventually might lead to a resolution of the continuing issue. The 'code of honour' comprises such items as what might be a legitimate object of a dispute, how opposing views are to be supported, what kind of evidence is admissible, where opponents may publish and in what style they ought to argue.

A sociologist would say that disagreement in science has become institutionalized. This holds also for other forms of conflict regulation, be it now in form of the parliamentary system, the legal system or the rules of economic competition. Imperfect as these procedures may be, they nevertheless signify that society or the scientific community has found a way in which it can "agree to disagree".

Yet the realm of our life which is institutionalized covers by no means all of our existence. There are disagreements which fall outside the established order. There are opponents who choose to challenge the rules themselves. There may be instances in which the existent rules may seem hopelessly inadequate to cope with a new situation. And there may be occasions when the boundaries between what passes as a scientific and a non-scientific argument are blurred, when attempts are being made to introduce a new kind of rationality (6). This is the area of non-institutionalized controversies, a fascinating time of intellectual and social upheaval where, amid all the turbulence, attempts are being made to come to a new AND DIFFERENT understanding of reality. For, however the controversy may end, it is quite obvious that the opponents are engaged in what is nevertheless an interaction process, antagonistic as it may be, in which the moves, strategies and perceptions of one side have inevitable repercussions on moves, strategies and perceptions of the other side.

III. Responses to Uncertainties

Generally speaking, controversies therefore indicate uncertainty and confusion with regard to two important dimensions:

- a) how to interpret a given situation or environment;
- b) what response is most appropriate for a given situation or with regard to a given environment.

In an institutionalized controversy, it is possible, by relying on both individual and institutionalized constraints which effectively discourage the involvement of an entire discipline with specific social problems (7), to narrow the area of uncertainty with regard to both dimensions. In a non-institutionalized controversy, however, these constraints do not operate, thus allowing this double uncertainty to set into motion the internal dynamics so characteristic to them: their tendency to develop from an original core argument to expand into other domains originally not connected with the primary argument. Non-institutionalized controversies therefore have a tendency to develop around a core argument by incorporating those domains which lend themselves either to interpret a given situation more fully, or to provide a more complete response pattern to be adopted. In this search, simplifications and short-cuts in reasoning are bound to occur, as that which counts most is not the details (which are believed solvable at a later stage also) but rather the total configuration of a response pattern thought to be more in line with the new interpretation of reality.

In a highly simplified way one could speak of society having at its disposal a limited set of "response patterns" which are triggered off according to the social definition of an environment. These responses can be divided into those highly routinized ones which are appropriate for recurring, 'normal' events and environments; responses which are reserved for events and environments falling outside the acknowledged routine which occur at irregular intervals (non-routine events) and finally responses which are neither, because they constitute an answer to novel situations and therefore have to be innovative.

Which response pattern is held to be appropriate depends in turn on a complex process of 'social construction of reality' by which sociologists mean that situation and environment have to

- a) be socially defined, i.e., categorized in conventional and shared ways, and

- b) be interpreted, i.e., meaning has to be assigned to a situation or environment.

These cognitive processes are fundamental in order to bring stability into social life and to enable socialization through continuation. The process of how new definitions and interpretations are being diffused has been described as 'societal learning' and is essentially a process of communication (8).

As individuals in society occupy different positions, their definitions and interpretations will differ, depending on their structural location, which are equipped to varying degrees with resources such as information or power. From this follows that

- a) certain individuals and groups - designated sets of actors - have more power to define/interpret a situation than others (this certainly holds for scientists in our type of society); and
- b) actors in different locations will differ in their definitions/interpretations.

As a consequence of these processes, social definitions of reality undergo constant changes (expressed in the emergence of new theories or whole scientific paradigms, of new world-views and ideologies) which, for the most part, are continuous rather than discontinuous, largely as a result of the stability of power structures in a society. - The emergence of controversies indicates either that dominant definitions of social reality are challenged, or that previously common interpretations no longer command consensual acceptance. As a result, the appropriate response patterns are also called into question.

The first challenge was addressed to the safety assumptions underlying the promised benefits of the 'Faustian bargain' (to use the somewhat pretentious term coined by A. Weinberg) opening up a prolonged debate which still continues with shifting emphasis. It ranged from controversial issues on radiation levels, carcinogenetic effects, probabilities of accidents, the safety of emergency cooling systems, toxicity of plutonium to problems connected with waste disposal and storage of nuclear material, including theft and sabotage prevention (9). The second broad area of uncertainty which is just beginning to emerge, concerns the economic assumptions - notably calculations of future energy demand and various versions of calculating the economic rentability of construction and operation of nuclear power plants (10). The third area of uncertainty is political in nature - it is indicated in the debate on licensing procedures

and how to set up legislative regulatory standards for adequate public participation in a field in which decision-making and planning processes require considerable technical and scientific expertise. While the implications seem too important to be left to experts alone, adequate forms of public participation have yet to be found.

What has led to the emergence of these successive uncertainties, leading to different interpretations of basic factual information and to radically opposed views of the courses of action to be taken? What is at the root of these controversies?

IV. Uncertainty as a Determinant of Risk Perception

Observers of the nuclear energy science agree that the initial stage of the commercial exploitation of nuclear energy was characterized by low risk perception, virtual absence of public concern and/or public pressure and relative high expectations of both, economic and technological benefits (11). The last years have seen a dramatic change, originating in the US and - with a certain time lag - spreading eventually to other countries, notably in Western Europe and Japan. It is plausible to assume that certain external factors were instrumental in this development:

- the rapid rate of stepping up the construction of nuclear power plants and planning for further growth of the nuclear energy sector;
- public knowledge about nuclear power installations and therefore their symbolic 'visibility' irrespective of physical appearance which predisposes a plant as a symbolic spearheading large-scale technological expansion and economic growth;
- the general inherent inability of public institutions, both in terms of legislation and political decision-making processes, to anticipate all future aspects of a technological innovation in need of such regulation and therefore its vulnerability to reproaches of unpreparedness;
- relative inexperience with public participation in a technologically complex planning process;
- unpreparedness and inability of the public to make the kind of cost-benefit analysis the promoters of nuclear energy expect it to make. Expected benefits are not spelled out sufficiently (the promises of 'cheap' energy and of tapping an 'infinite' source of energy are rather abstract). The visibility of expected benefits has been extremely low (see also p. this text). Costs, especially in the form of

risks, began to loom large after wide press coverage was accorded to the first controversies and 'incidents' in power plants reported by the mass media, thus opening up new sources of public anxiety;

- public anxiety was reinforced by the energy crisis which suddenly showed that what was hitherto taken for granted - an unending supply of energy - was no longer the case and that, as choices for energy supply narrowed, an intensification of the nuclear power programme was to follow.

As can easily be shown through an analysis of articles appearing in the mass media and other sources, both risk perception and the perception of public concern have steadily been on the increase in the last couple of years (12). As a consequence, the trade-off function between expected benefits and expected risks, including those of a political nature, has been altered. We must emphasize here the role of perception, both with regard to the alleged dangers and risks connected with nuclear energy, and the attention accorded to public opposition and concern. While some scientists would argue that 'real' risks are much lower than the ones perceived by the public, and especially the opponents of nuclear energy, it can also be shown that politicians and the public alike perceive opposition to nuclear power as much greater than it actually is reflected in public opinion polls (13). Yet, it would be grossly misleading to dismiss both risk perception and public concern as being 'mere' perceptual phenomena with the allusion that they are therefore somehow less 'real'. Such a view would rest on a gross misreading of the underlying social and psychological mechanisms. Although it can be argued that perceived risks must differ from 'real' risks, as measured by conventional scientific methods and standards, it is the very convention of defining risks in the established way which has come under attack. Furthermore, attitude surveys, although reflecting the current state of public opposition, are a poor indicator for the potential failures or successes of a social movement (14).

The present situation of high perceived risk and high perceived public concern should rather be interpreted as indicative for the general societal uncertainty which is at the heart of the nuclear power controversy. The uncertainty is manifest in a blurring of boundaries of what is generally believed to be objectively measurable risk and risk perceived by individuals, i.e., subjectively. High perceived risk, whatever its discrepancy to risk conventionally measured and defined may be, is therefore likely to have repercussions on these measurement standards and will eventually lead to their re-definition. The attention

accorded by politicians, industrial promoters of nuclear energy and scientists to the opponents of nuclear power acknowledges the relevance of what might otherwise be dismissed as a passing, irrelevant phenomenon in the process of which the opposition, however small in 'real' size, acquires political relevance and therefore becomes 'real'.

Haefele has argued that "hypotheticality" which characterizes much of the discussion on residual risks connected with nuclear energy, is characteristic and unique for the 'pathfinder role of nuclear power' (15). Hypotheticality is used by Haefele in two different ways: one meaning accorded to hypotheticality is that the potential consequences can no longer be fully experienced and not experimented with. This is of course true, although many scientific disciplines, including large parts of the social sciences but also such disciplines as astronomy, are subject to the same conditions. The second meaning of hypotheticality has to do with the style of argumentation: it implies (p. 318) that hypothetical considerations of the kind "imagine, if" enter the debate, which, by their very nature, cannot be proven or disproven. Hypotheticality in this second meaning appears not to be unique to nuclear power either but a feature of controversies in general, where the domain of the unknown potential consequences is hypotheticality explored and purposefully used according to one's preferences. Hypotheticality in this second sense thus points once more to the basic perceived uncertainties.

V. The Nature of Para-Scientific Controversies

Several writers who have analyzed controversies, especially in the form of disputes between experts, have commented on the existence of true theoretical ambiguities. A. Mazur (16) in an analysis of parallels between the fluoridation controversy which took place in the US in the 1950s and the more recent opposition against nuclear power, has concluded that the controversies are similar in so far as they focus largely on similar technical questions, such as the harmful effects of long-term exposure to low level of doses of fluorine or radiation. In examining the scientific or technological content of these disputes, he cautions that the outcome can be predicted on scientific grounds alone: comparative analysis suggests that the political, non-scientific context of the dispute might be equally important in determining the outcome. Mazur also notes that rhetorical devices, especially in the form of flat denial of the opponent's claims to evidence, form an integral part of the debate. Another large part of the debate is taken up by what he calls "arguing about different problems", which essentially means that the arguments presented by each side are not really confronted, as each side is arguing about different points. What is 'in error' or 'correct' will

therefore depend on what is being calculated and what one is most concerned about. Mazur then points to remaining theoretical ambiguities: a technologist or scientist soon comes to realize, he writes, that the complex technical problems of the state-of-the-art require subtle differentiations of the sort which cannot easily be articulated explicitly. When it is necessary to make a simplifying assumption (and many are reasonable), which simplifying assumptions should be made? What data are lacking on a question, to what extent may one reasonably extrapolate from data of other sources? How trustworthy is a set of empirical observations?

Mazur sees in the lack of formalized guides for judgement, such as they exist for the routinized procedures of science, an important source for disagreement. Other sources are discrepant data, and disputes in which different interpretations and conclusions can easily be drawn from a piece of factual information (17).

However, I wish to emphasize the point that these theoretical uncertainties and true ambiguities, taken by themselves, only reveal the cognitive siting of POTENTIAL controversies. As I have pointed out elsewhere (18), what has to be explained is not discrepancies in scientific thinking and research procedures, but rather why these differences - which exist to certain degrees all the time, without hindering the scientist's work or the growth of scientific knowledge - suddenly begin to matter. What has to be explained therefore is why opponents literally speak about different things, why they see what they do linked to different purposes and why they feel that theoretical ambiguities and uncertainties, genuine as they may be, call for different courses of action. The process through which what is merely a potential controversy is turned into an actual one, can only be understood if the link of knowledge to action, its different uses for action, are taken into account. Knowledge itself becomes controversial, not because it is otherwise perfect, but because it can be used for different ends.

It is this crucial transformation of a potential controversy into an actual one, which needs to be examined closer. Heightened sensitivity on the part of mass media and the public and, as a consequence, of politicians as well, are the result of a process through which the domain of theoretical uncertainties becomes linked effectively to uncertainties and different interpretations of reality existing outside the scientific field. According to this interpretation, the nuclear controversy is therefore an instance of a more general phenomenon: it is a para-scientific controversy. What started as a controversy among experts is no longer contained, but ties in with a developing social

movement. It is in this context that we must note the role played by scientists who oppose nuclear power and who, in fact, are transforming what could well have remained a scientific controversy into a para-scientific controversy.

I have chosen the term para-scientific, rather than trans-scientific (19), because it corresponds more adequately to the inner dynamics of the controversy's development, namely its gradual expansion and growth around a scientifically derived core of argumentation. Whatever theoretical uncertainties may have existed from the beginning on, they were soon interpreted as having relevance for social action and were linked to certain consequences which mattered not only for science but for society. As the controversy ceased to be a scientific controversy, i.e., one contained within the scientific community, science also ceased to give answers to the questions that were being asked. Yet, the arguments produced by scientists against nuclear power do not cease to be scientific arguments. They retain this quality as long as they are being put forth by practicing scientists, even though they are challenging the established conventions, measurement standards and techniques or data interpretation of science. Scientists opposing nuclear energy continue to play a dominant role in the public controversy. My hypothesis is that the debate would long have died, if it were not kept alive by a continuing intellectual input consisting of scientifically derived arguments. Although the scientists themselves no longer engage in what could be called a purely scientific controversy, i.e., debate which follows well institutionalized rules, they nevertheless retain their status of scientific expert, a status which provides a crucial link to the wider public debate derived from the original scientific argument. It is as though some of the ambiguity surrounding the issues themselves has been transferred onto the scientists: while engaging in scientific work, they have also overstepped the boundaries of established scientific rules, with the legitimation derived from the public role. Taking part in the public debate, acting at times as initiators and leaders, they fulfill essentially non-scientific rôles, but on the very basis of their scientific expertise. It is the scientist/activist, active in public cause, who is one of the prime movers of the opposition. In this relatively new, ambiguous rôle we can see him as spearhead of a movement to construct a new social reality. The scientist/activist is the scientist no longer engaged in the extrapolation of a reality which is assumed as given, but in the construction of a new reality, the mandate for which is derived from a confluence of scientific expertise and the demands emanating from the supportive field of the public at large. If we interpret his actions as a response to uncertainties, they must, as a consequence, exist on two different levels: the theoretical-scientific level and the social-political

level. While the public opposition uses arguments which are scientifically derived, the scientist/activist in turn gains his legitimation from working for a public cause. The parascientific circle closes here. Scientists/activists are thus engaged in building up a body of counter-knowledge and counter-expertise to be used in the public movement against nuclear power - but for whom? What are the roots for opposition outside the scientific camp and what grievance lead individuals and groups to engage in social action opposing this form of energy?

VI. Public Opposition

As stated in the introduction, public opposition can take different forms: it can consist of concrete local resistance usually emerging spontaneously as a consequence to the announcement of a planning decision taken long ago or it can consist of the formation of various kinds of citizen groups and other groups organized on the basis of their common opposition. To some extent there will be overlapping membership and other ties finding an outlet in the transmission of tactics, in the movement's literature and in a more general feed-back system: in order to sustain its momentum, both by gaining new recruits and by expanding its ideological core, the movement depends on local opposition, while the latter can be seen as a series of independent events forming part of an ongoing protest movement.

It can be observed that this incorporation of local incidents into the wider social movement is accompanied by a shift in emphasis of concerns: purely local features, fears and anxiety expressed on the individual level, tend to give way to necessarily more general - and therefore also more political and economic - concerns. The 'politization' of the debate is seemingly a concomitant feature of the movement gaining a wider basis.

Local opposition to nuclear power, is relatively well documented in case studies (20). It is a highly visible form of social action, usually well publicized through the mass media. Somewhat similar to the student movement and ghetto revolt in the US, it has led to inquiries about socio-economic background of the participants and leaders, the kind of issues which have dominated the conflict, and attempts have been made to retrace the course it has taken. From a number of case studies - which can be supplemented by investigations into similar forms of local opposition a number of generalizations can be made, among which we shall, for the present purpose, only report on the effects that scientific and technical expertise has on the controversy.

Ironically, although expert advice can help to clarify certain technical issues, its overall effect is that it is likely to increase conflict. From the study of such controversial issues as airport siting, fluoridation, DDT, SST and various environmental problems, it appears that the following propositions, originally observed by D. Nelkin (21) also hold for the nuclear power controversy:

- Originally, it was the promoters of nuclear energy who used expertise to legitimize their plans and, by the virtual monopoly they have over technical expertise, use it to justify their autonomy; this monopoly of expertise is now increasingly challenged by various citizen and 'advocates' groups, who are concerned about the implications of expert decision-making for public action.
- It can be shown that information alone is a poor instrument to make people change their opinion. The availability of technical expertise to both sides in an already ongoing conflict is therefore likely to increase, rather than decrease conflict. Expertise that is opposed on the ground that it is seen as linked to a certain position, is therefore going to be rejected. Propositions for conflict resolution or for public acceptance which are based on the demand for 'more information' are likely to fail if the source of this information, the credibility of the source, and its perceived links to established interests are not taken into account.
- The extent to which technical advice is accepted depends less on its validity and the competence of the expert, than on the extent to which it reinforces existing positions. Such factors as the credibility of authorities, and the economic and political context in which the debate takes place, will therefore have a greater impact than the quality of technical advice as such. This selectivity on the part of the public to accept advice not so much on the basis of the quality of content, but how it can be fitted into the overall conflict is paralleled by the other side and shows the instrumental use of expertise.
- There exists an asymmetry with regard to
 - a) the power to control information as the flow of information is always from technical experts to the public and not vice versa and thus gives more power to the experts;

b) those opposing a decision must not muster equal evidence, as it is sufficient to raise doubts and questions which will undermine the expertise of experts.

- Conflict among experts as a whole tends to reduce their political impact, as the influence of experts is based on public trust in the infallibility of expertise and, as once has been remarked, the ability of science to give a clear "yes-or-no" answer. To the extent that experts engage in public disputes, the oversimplified and deferent public view of scientific knowledge and expertise will undergo revision - scientists may begin to look more like other professional groups, e.g., lawyers. On the other hand, public trust in scientific authority is still extremely high (24) when compared with trust in government and other public institutions (22).

It is important to note the elements of continuity that link local opposition to the wider social movement and render what might otherwise be isolated, spontaneous incidents of purely local significance, into a more or less coherent series of outbursts of public indignance and resistance against nuclear energy. The first element of continuity constitutes the body of counter-knowledge and counter-expertise as it is built up by scientists/activists. It forms the necessary core of argumentation which is transmittable from one local incident to another, can easily be modified to suit local peculiarities and if necessary can be expanded to contain additional arguments. If not in motives, so in form and content of the arguments presented, public opposition depends heavily on this scientifically derived core of expertise. The arguments themselves form a rather limited, highly stereotyped and simplified repertoire which is equally true of the public arguments of the promoters of nuclear power to be used in a kind of ritualized antagonistic inter-action provided by such occasions as public hearings, press conferences, etc. Priorities in argumentation are set according to the exigencies of the occasion. Prominent scientists/activists may support the argumentative repertoire by personal appearance. Means of transmission for this body of knowledge is the movement literature, pamphlets and similar literary products written for the occasion.

The second element of continuity which units local incidents is knowledge and organizational skills, especially in tactics as they have been built up through experience. Although it is often difficult to foresee what course events may take in a local conflict (contingent as it may be on fortuitous events, such as crises in credibility of public authorities, individual leadership qualities, over-reaction by public authorities such as calling in the police, etc.) there exists nevertheless a number

of tactical guidelines which is derivable from experience that others have had. Through both official press coverage and informal channels, every single victory score or defeat is transmittable for the benefit of other communities and local opposition groups wherever and whenever needed.

Yet local opposition, by its very nature, constitutes rather a re-action to events coming from the outside. It is therefore highly contingent upon such external factors as the rate of nuclear expansion in a country, its visibility, press coverage of single incidents, such as accidents reported in the press, and the political skills of the promoters, as can be illustrated by the case studies.

For these reasons we would expect local opposition to slow down as a correlate to a decrease in nuclear construction activities or a change in any of the other factors mentioned above. Or conversely, to increase if a serious accident would occur or promoters continue with a siting policy which - due to the lack of adequate preparation of those concerned - may result in what has been described a 'planning shock'. The much more crucial and interesting part of the opposition is therefore opposition which is NOT tied to local incidents and as it expresses itself in the formation of various organizations, such as Friends of the Earth and other environmental groups, and as it spreads by becoming incorporated into the ideological programme of political parties, churches or other permanent groups. Opposition to nuclear energy as an IDEOLOGICAL issue, as well as a POLITICAL one, which it eventually is bound to become when decisions have to be reached, can therefore only partially be explained by analyzing local opposition alone. Although it is important to see how this wider form of opposition both relies on local resistance (which is invariably interpreted as a confirmation of one's own point of view and as an indicator for the grass-root support every ideological and political movement needs) and vice-versa, supports it by providing a more permanent organizational base for knowledge and organizational skills. We nevertheless have to turn to an examination of the opposition movement as a form of social movement.

VII. The Social Movement Opposing Nuclear Power

Social movements can be interpreted as a response to social change, either by opposing it or by trying to bring it about. They have their origin in social conditions which are perceived to be problematic, and constitute a response to some kind of strain, which may be experienced as deprivation, tensions, anxieties and the like. Historically, the most frequent strains have resulted from economic crises, wars, domination, mass

migration and technological change (23). Traditional or anticipated ways of life of certain groups are disrupted, expectations that previously guided actions are no longer valid, positions of economic well-being, prestige and power are threatened. Social movements are therefore non-institutionalized forms of collective behaviour that attempt either to produce or to prevent social change.

Strain alone, as is amply documented by the literature, is however not a sufficient condition for the emergence of a social movement. It must find its ideological basis, a political context which is conducive to certain forms of action and it must be able to draw on a wider social base for recruitment and mobilization. Where can we fit the wider public opposition against nuclear power into this general sociological frame?

Diffuse, Societal Concerns

On the most superficial level, perhaps, opposition against nuclear power can be interpreted as yet another manifestation of an anti-technology movement, such as they have occurred throughout history. While there may exist a small segment of genuine anti-technologists in the movement in the sense of traditionalists clinging to their inherited way of life, the social basis of recruitment of the movement seems to be much wider (24). There is a heavy representation of middle class and professional groups in some of the ecological movements. By the very nature of their concerns opponents must rely on scientific and technological advice which, at the very least, cannot make it easy to adopt a simplified anti-technological stand. Although the era of unquestioning adulation of all technical and scientific endeavours, hailed as a sign of progress which will deliver mankind of all its evils, certainly is over, we find little evidence of an outright anti-technological movement. Rather, the prevalent attitude of the public seems to be one of ambivalence toward technology. In a recently conducted survey it was found that positive public response to technological development was overlaid with a set of concerns about the more general consequences of that development. There was a significant increase in the public's distrust of all public and private institutions with respect to decision-making and it was felt that government officials and business leaders have an undue amount of control in the implementation of technology (25).

Another set of diffuse concerns which has surfaced in the controversy about economic requisite for nuclear energy expansion, is the concern that it is symptomatic for the kind of over-industrialization, characteristic for overstepping the 'limits of growth', put before us as warning signs by the Club of Rome and similar institutions. Nuclear energy planning has

to be linked with the planning for wider industrialization if it is to be efficient, which leads to concerns about further destruction of whole regions and a distinct feeling that economic planners move ahead too far and too fast (26).

The third set of diffuse concerns are ecological ones. American polls have revealed how powerful these concerns are and that they are seriously underestimated by politicians, businessmen, regulators and even environmentalists (27). Almost every argument in the nuclear energy debate can be seen to have ecological consequences, just as much as economic ones.

These three sets of public concerns - technological ambivalence, fear of over-industrialization and ecological concerns - are certainly present not only among those who oppose nuclear power, but in a diffuse way in all segments of society. They form an undercurrent in public sentiment, yet, taken by themselves, cannot explain the opposition against nuclear power.

Specific Grievances and Demands

If we now turn to an examination of more specific grievances and demands, such as they have emerged in the debate, we can clearly see how opposition has formed as a consequence of lacking preparedness in the political and legislative institutions. Specific demands have addressed themselves - ranging from more narrow to wider issues - to the following:

- purely local demands to forego the construction of a reactor on a chosen site;
- demands to achieve modifications in regulatory standards, i.e., tighten governmental control on industry, both with respect to standards as well as regulatory procedures;
- demands to allow some form of participation in the decision-making process, including the distribution of and free access to information which is the basis for decision-making;
- demands for public discussion of and participation in decision-making in the field of energy policy as a whole.

The rate at which economic and technological development has occurred on a world-wide scale in the last decade, has been accompanied by a concentration of power and decision-making to a previously unknown extent. This massive concentration process has not been matched by a re-structuring of, and an accomodation of, political mechanisms and institutions which would assure access to information and decision-making in concordance with the demands of democratic ideology. Not only have legislatures and political parties been completely unprepared to deal with the new problems, but there has been, at least initially, a strong tendency on their part to view the problems arising around the growth of nuclear power as merely economic and technical ones. It was only in the wake of citizen's protest and actions taken on the local level that politicians became interested in the underlying issues and even then, there was a tendency to dismiss the political nature of some of the issues raised as irrelevant (28).

It is only lately, for instance, that one of the major problems inherent in the growing concentration and centralization of facilities that serve regional areas, has begun to be recognized, namely the necessity to balance community concerns against social and economic needs on the regional or even national level. How, as D. Nelkin puts it, can the concern with resources in upstate New York communities be reconciled with the need for energy in New York City, or with the economic concerns of those who are less articulate than environmentalists or middle class citizens organizing a protest movement (29)? These are highly political problems which arise in a society which refuses to face up directly to questions of distribution of costs and benefits on a more equitable basis. Grievances and demands, as they have been articulated in the course of rising public opposition have tended to focus on real deficiencies and lags in the legislative and political institutions and their regulatory, procedural and wider economic and political implications. As political institutions vary considerably in terms of their responsiveness to public demands, adaptation to and accomodation of these demands has also tended to vary, as a cross-national study of responses to the opposition's demands probably would reveal. Furthermore, the problem is not simply to find a way in which opposition groups or society as a whole can be given access to information, as an important and contentious resource bearing on the distribution of political power. Response demands a re-structuring of the political process and institutions to allow for participation in a decision-making process, in which local, regional or national interests may be opposed to each other and calls for entirely new modes of distributing expected benefits which accrue unevenly to communities, regions and strata in society. Proposals that

have been made up to now to incorporate public participation are totally inadequate to tackle these new problems.

Ideological Elements

Any social movement's ideology focuses on and interprets strains that people feel. It consists of a set of beliefs that guide actions of leaders and participants and in this sense justifies and legitimizes the purpose of the movement. A social movement, however, is not a unified, highly structured organization with homogeneous beliefs. There are ad hoc formations, coalitions, overlapping membership sets, and by its very nature, differences in ideology and outlook not only among the various loosely structured parts of the movement, but also among leaders and followers. Some ideological beliefs arise as a response to the external setting in which the movement operates and thus address specific grievances that are felt. Others are more of a visionary or utopian nature - they are directed towards the image of a society different from the present one and having overcome, in some sense, the very strains under which people suffer.

While it is apparent how the opposition movement's political grievances and demands have been shaped by existing deficiencies, lags and unpreparedness of political institutions, the ideological thrust of the movement incorporates two distinct elements. One provides ideological bases for voicing essentially political grievances, the demand for more and wider participation. This ideological core the opposition movement against nuclear power shares with other movements, such as various forms of citizen's protest against airport siting, consumer advocacy, health care and planning advocacy. Key slogans, around which groups have mobilized, have been "accountability", "participation" and "demystification". Shared concerns have focused on the role of technical expertise, the misuse of the expert and, in general, the role of expertise in the planning process. The underlying dilemma resides in the fact that complexity of public decisions seem to require highly specialized knowledge, be it now in medicine, economic planning or technological decisions. Those who control this knowledge have often considerable power, while those, who will be immediately affected by the decisions, have little if anything to say. The ideology of citizen's 'advocacy' therefore demands to put expertise, as a political resource, at the disposal of communities and groups as well and to change decision-making structures in such a way that the ordinary citizens have a chance to get their views heard (30).

In Western Germany as well as in France, the ideology of citizen's initiatives, in line with the overall political system which accords more weight to political parties than in the U.S., has centered on influencing political parties and centralized government control. One set of the ideological beliefs motivating and legitimizing citizen's initiatives and advocacy politics are therefore not unique to the opposition against nuclear power, but form part of a more general pattern of citizen's protest.

There is however a second ideological core which emerges in the nuclear power controversy only and which, in my opinion, has the potential for developing further into a unique platform for the movement. In order to appreciate it fully, we must return to what I regard as the ideological leaders of the movement, namely the scientists/activists. In analyzing arguments pro and con nuclear power that appeared in scientific and semi-scientific journals, I was struck by one dominant feature permeating all these arguments: the clash in time perspective, emphasis on and evaluation of the future. Although promoters of nuclear energy are by the very nature of their tasks, using long-term planning methods and therefore are familiar with couching their outlook into a long-term time perspective, the emphasis nevertheless rests firmly on a short-time perspective they have adopted. They express confidence that new solutions for unresolved problems will be found and that pragmatic incrementalism is the best possible course of action to follow right now. They confess a pervasive faith in the near future which they trust will bring the necessary technical solutions in due course of time (31). By contrast, the opponent's mode of thinking and argumentation rests on a long-term perspective: the distant future matters far more than anything in the present or near future. Therefore preoccupations and faith in finding solutions now are discredited in advance, as long as concerns located in the more distant future are not coped with properly.

The long-term time perspective that the ecological visionaries profess directs their concerns and worries fully to the future: storage and waste problems of nuclear material, the long-term effects of radiation and climatic alteration are what really matters. It is our children's children's future we have to be concerned with more than our own present. By contrast, proponents of nuclear energy recognize and acknowledge problems only insofar as they are pressing right now, and are wholly confident that scientific and technological development will come up with new solutions, as it has repeatedly done in the past. This outright contradiction in time-perspective is both a strong structural indicator for the present social position in which opponents and promoters of nuclear energy find themselves, and a cognitive

dividing line leading to an entirely different evaluation of the future for these groups, and therefore can serve to legitimize on the level of beliefs the stand they take in their present writings and actions.

VIII. Ideology and Social Structure

Ideology and beliefs are not randomly distributed in a society. Rather, they find themselves in a dialectical relationship with the position in a social structure in which individuals or groups are located. Depending on this position, an individual (or groups of individuals in similar positions) command different resources of power, prestige and economic goods and have access to different resources thus determining their relative power over time. The social-structural location in which they find themselves significantly shapes their outlooks, expectations and their images of social reality. They determine their and their children's life chances and the kind of expected benefits or threats social change may hold for them.

Differences in time perspective are a strong indicator for the structural position in which groups find themselves (32). Adoption of a long-term time perspective is indicative for those individuals and groups who - for whatever reasons - had to "displace" some of their aspirations, goals and claims into the future, because they were unable to accommodate them in the present. There is reason to believe that opposition against nuclear power on the ideological level which is unique to it, stems from individuals and groups whose aspirations and claims to power, prestige or economic benefit are not sufficiently recognized in the present and who feel threatened by losing out further through new technological developments. Broadly speaking this means that they may feel threatened to lose power and influence on decision-making which they now feel entitled to on the basis of their educational qualification and which they see increasingly concentrated in the hands of a few anonymous, primarily political and economically oriented decision-makers; there may be those who expect few additional gains from further industrialization, but who feel they have something to lose which is summarily described as quality of life or of the environment and finally those who, due to their marginal position, have little if any material gains to expect from the tapping of new energy sources, but feel disturbed in holding the present status quo of their material and social existence, based as it is on a rather precarious sense of security. On the other hand, those who can concentrate their efforts and concerns on the immediate future, disregarding the more distant future as relatively unproblematic, will be those who can expect immediate gains by seizing whatever opportunities, especially in economic terms, the present seems to offer,

those who still have faith in the future and expect their own upward mobility to continue like in the past and finally those members of the political and technocratic elite who by virtue of their preoccupations, believe in finding solutions within a short time span and in pragmatic incrementalism.

These are considerations, however, which still merit detailed empirical analysis.

The individual scientist/activist finds himself in a situation we can perhaps best describe as one of "restricted mobility", characterized by an excess of aspirations and concerns over actually existing opportunities for meeting them. There are a number of possible situations in which restricted mobility might occur, paradoxically on the top level just as well as on the middle and lower level of one's career:

1. The scientist/activist who after having reached the very top of his professional career, who has found recognition and professional prestige, turns towards engagement in 'a cause'. As many examples show, the cause may be directed towards broad humanitarian, but also philosophical or technological concerns, or may lie in another discipline.
2. The scientist/activist on the middle level and those engaged in managerial function on the middle level who feel their prospects of further mobility, either in terms of his professional advancement conventionally defined, or in terms of assuming wider social responsibility which carries with it wider recognition, incongruent with what their present situation has to offer.
3. Those who find themselves in such a position practically from the time in which they have entered a professional career which they find narrowly defined in professional terms not offering any opportunity for engagement in activities that would testify to the wider social concerns these individuals bring already with them.
4. Finally there are those who involuntarily get themselves into such a position, i.e., restricted mobility is imposed on them from the outside as a result of their activities which are seen as incongruent with a narrowly defined professional task. This has been the case for some of the most outspoken critics of nuclear power who attempted at first,

usually in vain, to bring their concerns and findings to the attention of the institutions in which they were working or the proper scientific bodies. After not having received the audience they wished for, they then turned to the mass media and the public, leading them into further professional isolation or even expulsion from their proper scientific careers.

The scientist/activist, finding himself in a situation of blocked mobility as a consequence of his attitudes, outlooks aspirations and claims and the career opportunities actually offered to him, has therefore more to gain than to lose by challenging the scientific establishment and by fusing his concerns with the wider social causes.

But, what about the supporters of the opposition movement for whom, as we maintain, the future holds equally little in terms of expected benefits and may even threaten to undermine their present position in the social structure? When promoters of nuclear energy speak of expected benefits, they usually think in rather global terms (benefits for all of mankind) and fail completely to perceive the differential effects these benefits will have on different social groups. No technological innovation has ever benefitted equally all segments of society. Especially in the original stage of technological application and commercial exploitation, some groups had much to gain, especially economically, and at the outright expenses of others (e.g., the introduction of the railway was accompanied with loss of land and basis of existence for those whose land was used; industrial workers, the introduction of the loom destroyed home-based industry, etc.). It may be true that eventually a process of diffusion of new technologies has set in which resulted in their common use, such as electricity. Historically speaking this process has been surprisingly slow and has tended to maintain existing differences in enjoyment of beneficial consequences.

What are the expected benefits of nuclear energy and who will benefit? First, we must note that the visibility of these benefits has been extremely low. Nuclear energy does not entail a qualitative change in the technological end-product it promises to deliver, namely electricity. From the point of view of the consumer, the qualitative change consists only in its production mode and not in its final product. Threats, as they have been uttered in the public, such as "the lights will go out, if we fail to develop nuclear energy", are however a poor substitute for positive incentives. Secondly, from a look at poll results' break-down into socio-economic strata opposing or favouring nuclear power, it appears that those who have to gain are above all those who expect to gain from further industrialization in general: skilled workers, industry and business, and the technocratic-technological elite.

Those whom we would expect to oppose further industrialization also oppose nuclear power: farmers and agriculturalists attached to their traditional mode of life as their living depends on the continuity of the status quo.

There is however, the remaining puzzle of the social origin of environmentalists, who, although not exclusively, nevertheless contain a strong element of middle class and well educated people; and those groups who albeit not themselves active in the movement, provide a supportive field of sympathizers and potential recruits to the movement, about whom we know very little. From the few accounts we have, it appears that the contact of national political institutions is a strong factor in selective recruitment: we expect politically active and articulate supporters, but also those whose interest in politics is rather negligible and who are primarily motivated by their distrust of political parties in general, government, industry and public institutions. Here again, further empirical work will be necessary.

It thus appears that certain segments of the middle class, namely those whose aspirations of upward mobility will not be honoured by further industrialization and those who fear that they will further lose whatever influence and social recognition they now hold, feel squeezed out of their present social positions. By focussing on the long-term effects of nuclear energy and by opposing it they express strain they experience in the present: that social change in the form of large-scale further industrial development, with its accompanying concentration of power and decision-making, holds little if any benefits out for them and threatens to further undermine their present position, both economically and in terms of their capacity to influence social and political development. They feel at best marginal to the ongoing technological developments calling for further centralization. Their demands are therefore directed towards de-centralization in decision-making, 'small' technologies, rather than 'large' ones; and protection of the environment as a resource preventing its falling into the hands of those who will only use it for their own benefits and at the expense of others.

On a preliminary basis we can therefore suspect that opposition against nuclear power in its social structures roots is opposition against those who will benefit from further economic and political concentration and centralization. It is directed against 'big' industry, seen in collusion with 'big' government and 'big' science. It is the opposition coming from those who feel powerless and small in the face of these developments.

IX. Outlook

The final question to ask concerns the opposition movements' chances for failure or success, in connection with concrete incidents, demands and grievances, and the movement as such, seen in a wider perspective and its potentiality in mobilizing additional segments of society. The evaluation of success or failure in local incidents is likely to be influenced by one's original stand in such matters. What may appear as a victory, such as a court decision to delay construction of a reactor depending further hearings, may equally be interpreted as a mere tactical manoeuvre to assuage public protest and therefore as a defeat. It is beyond doubt, however, that the opposition movement, especially in the U.S., has left its impact on regulatory standards and legislative procedures. On the other hand, the relaxed attitude of U.S. Government towards control of industry, has notoriously been a rather relaxed one, so that the success of the movement can be interpreted as merely catching up with the more stringent governmental control in Western European countries in general.

The open crucial question is, of course, whether one can truly speak of an opposition movement apart from local groups that engage in concrete, spontaneous but merely ad hoc actions. There certainly exists an organizational core of environmentalists with a more permanent basis. There is also, as I have shown, overlap with organizations that demand wider public participation in general. In the course of the public debate, politicians and political parties have become interested in issues which now figure in the political programme of at least some European parties. Finally there is, as I believe, an ideological core which appears unique to nuclear power opposition, as it lends itself by its very nature to expressing doubts, fears and opposition of interests with regard to the future. The potentiality of this movement to grow will, therefore, depend strongly on whether this ideological core - a long-term time perspective in which to evaluate effects of decisions which are taken now and evaluation of what the future should look like - can be fitted into already existing ideologies and fused with the corresponding organizational structures. A general debate on what the future of mankind should look like - if reasonably well articulated alternatives are presented - would open up entirely new perspectives, thus rendering fully visible those structural strains and conflicts of interests which are now hidden underneath the controversy for and against nuclear power.

References

- (1) Velimirovic, Helga. An Anthropological View of Risk Phenomena. IIASA RM-75-55, Laxenburg, Austria, International Institute for Applied Systems Analysis, November, 1975.
- (2) Otway, Harry J. and Pahner, Philip D. Risk Assessment. Futures, Vol. 8, Nr. 2, pp. 122-134, April, 1976
- (3) Bethe, Hans. The Necessity of Fission Power. Scientific American, pp. 21-31, January, 1976.
- (4) Gregory, Richard. Eye and Brain. London, 1976.
- (5) Nowotny, Helga. The Theoretical and Practical Significance of Scientific Controversies, 1976 (in preparation).
- (6) Toulmin, Stephen. Human Understanding. Vol. 1, Oxford Clarendon Press, 1972.
- (7) Barnes, S.B. On the Perception of Scientific Beliefs. In Barnes Barry (ed.) Sociology of Science, Penguin, p. 284, 1972.
- (8) Nowotny, Helga and Schmutzer, M.E.A. Gesellschaftliches Lernen. Frankfurt/Main, Herder & Herder, 1974.
- (9) See Hirsch, Helmut. Controversial Issue in the Exploitation of Nuclear Energy. Paper in Preparation, 1976.
- (10) See, for instance, Bossel, Hartmut, et al. Dialogprogramm zur Entwicklung und Ueberpruefung von Langfristkonzepten fuer das Energieversorgungssystem und Anwendung auf die BRD. Institut fuer Systemtechnik und Innovationsforschung, Karlsruhe, 1975.

- (11) Williams, Roger. The Case of Nuclear Power in the U.K. Paper in Preparation, 1976.
- (12) This point will be more fully documented in the empirical appendix of this paper, in preparation, 1976.
- (13) Majority Favours Nuclear - Harris Survey. Nuclear News, pp. 31-34, September, 1975.
- (14) Marx, G. and Wood, J.L. Collective Behaviour. Annual Sociological Review, 1975.
- (15) Haefele, Wolf. Hypotheticality and the New Challenges: The Pathfinder Role of Nuclear Energy. IIASA RR-73-14, Laxenburg, Austria, International Institute for Applied Systems Analysis, 1973.
- (16) Mazur, Allan. Disputes Between Experts. Minerva, 2, pp. 243-262, 1973.
- (17) See Hirsch, Helmut, op. cit.
- (18) Nowotny, Helga. Controversies in Science. Zeitschrift fuer Soziologie, 4, 1, pp. 34-45, January, 1975.
- (19) Weinberg, Alvin. Social Institutions and Nuclear Energy. Science, 7, pp. 27-34, July, 1972.
- (20) Nelkin, Dorothy. Nuclear Power and Its Critics. Cornell University Press, Ithaca & London, 1971. Battelle Institute, Buergerinitiativen im Bereich von Kernkraftwerken, BMfFU.T., Bonn, 1975. Wuestenhagen H.-H. Buerger gegen Kernkraftwerke, rororo, Reinbeck/Hamburg, 1975.
- (21) Nelkin, Dorothy. Political Impact of Technological Expertise. Social Studies of Science, Vol. 5, 1, pp. 35-54, January, 1975.
- (22) See Harris Poll, op. cit.

- (23) See the literature reviewed by Marx & Wood, op. cit (14).
- (24) Evidence comes from the case studies. So far, a systematic inquiry into the social background is lacking.
- (25) La Porte, T. and Metlay, D. Technology Observed: Attitudes of a Wary Public. Science, 188, pp. 121-127, 1975. Mazur, Allan. Opposition to Technological Innovation. Minerva, 13, pp. 58-81, 1975. Taviss, I. A Survey of Popular Attitudes Toward Technology. Technology and Culture, 13, 4, pp. 606-621, 1972.
- (26) These arguments are presented in Forum E, May, 1975, and other pamphlets of the movement literature.
- (27) Harris, Poll, op. cit.
- (28) This point is documented in the case studies, cit. (20).
- (29) Nelkin, Dorothy. The Political Impact of Technical Expertise. Op. cit.
- (30) These demands are borne out when one analyzes the present closed circle in decision-making: experts make forecasts which form the basis of the politicians' assessment of the situation, who then asks (often the same small group of experts) for development plans.
- (31) A correlate to this mode of thinking, as J. Linnerooth pointed out, can be found in Bayesian theory underlying most of current work on decision-making: it is the assumption that the decision-maker can always change choices made at a later stage at which new options might also appear.
- (32) Nowotny, Helga. Time Structuring and Time Measurement. In J.T. Fraser & N. Lawrence (eds.), The Study of Time II, Springer Verlag, Heidelberg-Berlin, pp. 325-342, 1975.