SUMMARY

The possibilities and limitations of technology assessment

in search of a useful approach

S U M M A R Y

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– in search of a useful approach – *)

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PREFACE

In June 1984, the Dutch Minister in charge of Science Policy presented a White Paper entitled "Integration of Science and Technology in Society" to parliament. This White Paper includes the following proposals (Ministry of Education and Science (1984)):

1. To initiate research directed at clarifying the social and ethical consequences of (the introduction of) technological innovation.
2. To establish an independent foundation to promote public information on science and technology, with the aim of "contributing to a well-balanced social basis for science and technology".

In the White Paper, a budget of approximately 1 million US dollars is set aside for Technology Assessment (TA) in 1984, increasing to approximately 1.5 million US$ in 1988. It is expected that the total amount which will be made available for TA research in the Netherlands will be considerably higher. The Minister expects ministries other than his own to also finance TA research.

By producing this White Paper, the Minister is providing an answer to the question of how he imagines TA will become assimilated into the political system. This question has always played an important part in the Dutch debate. This debate, which has been going on for some ten years, began, as it did in so many countries, with the proposal to establish a TA research office, just like in the United States (where TA originated), which would be linked to parliament. Such a proposal appeared to be impracticable in the political climate at the time (the mid-Seventies). In the ensuing years new proposals were put forward at regular intervals, stemming from discussions on nuclear power, micro-electronics and recombinant DNA. Parliament strongly urged a law to allow regulation of the practice of science. This idea, however, has been rejected in the White Paper "Integration of Science and Technology in Society", because it is too strongly oriented towards science and shows too little consideration for the societal applications of the results of science. The proposal to create an "Ombudsman for Science" met with similar criticism. Furthermore, the White Paper says that an ombudsman would be geared too much towards individual incidents and would not be able to work in a sufficiently systematic way.

The emphasis in the White Paper clearly lies on TA and on public information. A structure is proposed in which TA will be able to get off the ground in the Netherlands in a more or less institutionalised form. The White Paper does not, however, describe the exact form which TA in the Netherlands will take. The White Paper mainly deals with the formal responsibilities: informing the public will fall to an independent foundation and a special bureau will be created within the Ministry of Education and Science for the organization of the TA research programme. Practical specifications of the activities of both the foundation and the special bureau are scarcely mentioned in the White Paper, so there is still room for highly varied approaches.

The Centre for Technology and Policy Studies of the Netherlands Organization for Applied Scientific Research (STB-TNO) conducted research into TA to assist the Directorate General for Science Policy of the Ministry of Education and Science in preparing the White Paper. This research involved:

1. Evaluating the experiences with TA, particularly those in the United States.
2. Developing a TA concept which would be suitable in the Dutch situation.
3. Investigating the possibilities of and the need for TA in six fields of technological development.

A separate report has been written about the third point (Smits et al.

(1984b)). This report relates quite specifically to the Dutch situation an therefore no English summary is available.

The report which this paper summarizes (Smits et al. (1984a) deals mainly with the first two points. Both reports were presented to parliament as background studies for the White Paper*).

*) Both the White Paper and the two STB-TNO reports are available from the Staatsuitgeverij, Christoffel Plantijnstraat 2, P.O. Box 20014, 2500 EA The Hague.

1. TECHNOLOGY AND POLITICS

INTRODUCTION

The acceleration and broadening of technological progress have been indicated, together with the specific forms which technological development assumes, as causes of numerous social problems. According to Rammert, the most important problems in the Seventies and Eighties concentrate around three topics (Rammert (1982)), p. 14 et seq.):

- *The introduction of new technologies and its consequences*: these include nuclear power (safety, health, waste, the nuclear state, genetic consequences), microelectronics (unemployment and the displacement of labour as a consequence of automation, decentralized work, the quality of working life), information and communications technology (the threat to pluriformity and privacy), chemical technologies (environmental pollution, food safety, the safety of production processes and side effects of products), biomedical engineering (genetic engineering, effects in medical applications and contributions to the solution of the food supply problem) and military technology (missiles, the neutron bomb, chemical and biological weapons, laser weapons).
- *Assessing the technological and social alternatives*: this involves, on the one hand, alternatives within present-day industrial culture (environmental technology, the conversion of military production to civil production) and, on the other hand, alternatives which are based on a different system of values and a different view of the world (small-scale enterprise, cooperatives, adapted technology for developing countries).
- *Natural and social limits of technological development*: of great significance in the early Seventies, then faded into the background for a period, once again forming a focus of interest at the beginning of the Eighties due to the problem of acid rain, the CO_2 problem (hothouse-effect), large-scale unemployment, the threat of nuclear war, worldwide deforestation and erosion and the food supply problem in the Third World.

In this publication we would like, among other things, to deal with the question of what "politics" can do to help solve these problems. First of all we will define in more detail how we understand the term politics in this connection.

In political science two different concepts of "politics" are distinguished (Fennema (1982)). The first concept, which is used most frequently in the policy sciences, is based on the premise that politics are "the articulation of social conflicts and contradictions at the level of the state". This is a narrow definition of politics, in which the role and the position of the state and the government are central. In contrast, there is a broad definition of politics which is based on the assumption that any exertion of power is a form of politics. This includes all activities which are involved with social change, i.e. with changing or perpetuating relationships between (groups of) people. The broad concept of politics has the advantage that it does not only cover actions which are directed at the government or interests to be substantiated via the government. In disputes and conflicts concerning technology, it is frequently the case that relevant activities take place, at least partially, outside the framework of the state.

Persons are involved in technology in very different positions and their opportunity to exercise influence varies greatly. In practice, it appears that only part of this influence runs, in the narrow sense, through political channels.

The three controversies concerning technological development indicated by Rammert have given rise to a political climate in which it

is considered desirable to have more coherence and depth in the discussions about these controversies. Connected with this is the desire to improve the consistency of decision-making with regard to technology. The development of technology and the emergence of controversies are social processes over which the government has only limited control. For the government this is a condition which has to be taken into account. One important question, therefore, is how the government, under these conditions, can contribute to increasing the political options with regard to technological development.

TECHNOLOGY ASSESSMENT

TA originated in the United States at the end of the Sixties can be regarded as one of the answers to the rising demand – also in the United States – for better means of directing technology. In addition to this, the Congress' desire to strengthen its position versus the executive power played an important role in the American discussion on TA.

The idea behind the TA concept is that it will be easier to direct technological development by conducting research into the effects which a new technology could have on society as soon as that new technology is introduced. This idea can be traced to the various definitions of TA.

The following are two such definitions:

"Technology Assessment is the name for a class of policy studies which attempt to look at the widest possible scope of impacts in society of the introduction of a new technology or the extension of an established technology in new and different ways. Its goal is to inform the policy process by putting before the decision maker an analysed set of options, alternatives and consequences. (It) is extremely wide sweeping in scope; it is not the decision process itself, but only one input into that proces". J. Coates (1976), p. 139.

"Technology Assessment is a process which aims at the systematic identification, analysis and evaluation of the social consequences of the introduction and use of a technology". E.J. Tuininga (1975), p. 131.

As can be seen from these definitions, the claims of the TA supporters were far from modest. For them and also for many (relative) outsiders, TA seemed to be *the* answer to the need for information which had arisen as a result of the demand for democratic supervision of policies affecting technology.

The TA concept struck a responsive chord. In 1972, the Office of Technology Assessment (OTA, with about 130 employees at present) was established in the United States by law. It was very closely linked to Congress. TA, however, did not remain an OTA monopoly. In the U.S. other organizations, including the National Science Foundation and the Ministries of Transport, Agriculture, Health and Energy began to involve themselves with TA. The TA movement was also set in motion in countries such as Canada, Japan, West Germany and France.

In the Netherlands, the discussion on TA in the mid-Seventies led in parliament to proposals from Terlouw (MP for the party "Democrats '66"), to arrive at a Dutch variant of OTA (also, therefore, to support parliament). These proposals, however, did not succeed and TA has never been able to achieve the institutionalized position in the Netherlands as it has in the United States and, recently, in France.

For a long time it seemed that the discussion had died down in the Netherlands. In recent years, however, there has clearly been a change. The report from the Rathenau Commission (Advisory Group

for Microelectronics (1980)), in particular, gave considerable stimulus to the Dutch TA discussion.

In the early period, there was quite a lot of optimism about the capacity of TA to be instrumental in political decision-making. At first sight that also seemed realistic: the more and the better the knowledge about a specific technology and its effects on society, the more rational could the political decisions be which would be made on the basis of that knowledge.

In contrast to this, however, is the fact that TA does not make the decision-making process any simpler. An increase in substantive knowledge does not reduce the number of options. On the contrary, the number of choices is often increased (Pollak (1982)). More knowledge, therefore, can reinforce the substantive rationality of a decision to a considerable extent, while at the same time rendering decision-making itself more difficult. In politics, however, one is also concerned with a different form of rationality: political rationality. Renate Mayntz notes:

"The criteria of political rationality, which is oriented toward the goal of political survival, are different from the criteria which define the substantive rationality of a policy decision.
To avoid losing support and to collect visible success or at least applause for oneself, one's party, and the present government are eminently rational actions in view of the goal of political survival" (Mayntz (1982)), p. 2)

In other words, the building up of power and the maintenance of positions of power both play a very important role in politics. The stake in this "game" is the influence of various groups on the broad and as well as more specific developments in society. In the end important elements in this game are differences in objectives, in definitions of problems and in strategies for solution.
The egotistical and rather abstract aim of political survival is therefore not the only aspect to political rationality. It is perhaps more important that a concept like this leads to the conclusion that political decisions must find support among the various parties actively involved, both in the phases when the decision is being formed and when it is being implemented. For this reason processes such as solving conflicts and reaching consensus and compromise are essential in the process of political decision-making. These processes determine the political feasibility of decisions and therefore also the content of those decisions.
Political rationality is more important in political decision-making than substantive or instrumental rationality.

What does the so-called "primary of political rationality" mean for the aim of improved decision-making on technological development?
In our opinion this signifies mainly that a policy directed at the provision of information for decision-making about technological developments must be oriented at the processes of conflict resolution and the formation of consensus and compromise. During these processes it becomes clear which information is required and which information can play an important role.

Our work is based on the premise that TA has to lead to more democratic and (as far as content is concerned) more rational decisions and on technological developments. We will not provide exact details on how we specified these concepts, since this falls beyond the scope of this publication. For us they mean with respect to TA that:

– there are various positions and causes interests with regard to technological developments;
– some groups have more economic and political possibilities (and knowledge) at their disposal to propagate their position;
– the various positions may be seen as potential sources of strategies for arriving at solutions and of values and standards in the lights of which strategies can be assessed;
– the ideas and claims of groups who have limited opportunities to substantiate these on the basis of scientific research can be interesting and important enough to be developed further.

Such an approach can lead to a deepening (more rational with regard to content) and reinforcing of political decision-making on technological developments. Political decision-making, which is often characterized as reactive, will assume a much more active character, particularly because this approach stimulates the development of ideas (including political ideas). A policy directed at generating ideas on the future development of society and the place of technology within society will give impetus to the discussion about possible solutions and thus put it on a higher level. In this way the policy contributes to an increase in the substantive rationality of decision-making both within the formal political circuit and outside it. As a result the situation in which politics and policy aim at "quick solutions" on the basis of power (in which a single position can dominate the decision-making) or "quick compromises" (in which the content of the problem can be bypassed) can be prevented in some cases.

It is in this way that the foundations for the organization of TA are laid. In the remaining part of this article we will explain in detail how TA in the Netherlands can be given form. First of all, the experience gained in the past with TA - and in particular in the United States - is analysed in chapter 2. In chapter 3 a new TA concept is proposed and detailed. Finally, the role of the government in realizing the TA infrastructure proposed in chapter 3 will be discussed in chapter 4.

2. EXPERIENCES WITH TECHNOLOGY ASSESSMENT AND RELATED ACTIVITIES

INTRODUCTION

Although the idea of TA has found a lot of response and has certainly also led to results, the discussions about TA are often still characterized by a note of disappointment. Initial expectations that TA would contribute considerably to the social directing of technological developments seem not to have come true:

- TA has not become the "Early-Warning System" many had hoped it would. The most important criticism of OTA for example is aimed at the fact that OTA does not direct itself to the long term but rather concentrates on the short-term problems of the Congressmen. Casper (1978) further points out that OTA has failed as an "Early-Warning System" because large parts of technological development which are of major importance to society but are rather delicate issues from a political point of view (military and space technology) have consistently been left out of consideration.
- With regard to the influence of TA on policy-making, opinions are generally not very positive either. This influence is considered of relatively little importance.
- Finally, the general public, like the professional policy-maker, does not seem to take results of TA, nor a policy which is based on or which legitimizes itself by referring to TA, for granted. It is the rule rather than the exception for results of TA research to be severely criticized.

Disappointments are not only affected by the final results but also by the expectations which have been raised and the way in which people have tried to live up to them. One can ask the question whether the expectations of the first years of the TA movement - which still play an important role in the discussions of today - have been very realistic ones. Here follows, in a somewhat exaggerated form, a number of these expectations:

1. People thought it possible to acquire, by means of research, *reliable* information about *all* relevant aspects of *future* technological developments.
2. Policy-makers would not be able to ignore TA research, also because of the above-mentioned expectation, and would have to take account of it in their policies. The general public and the stakeholders would accept TA-based policies.
3. It was considered possible to get this information by putting rather unspecified questions to multi-disciplinary research teams. The representatives of the various disciplines within such a team were certain to see to it that in the research all relevant aspects would be taken into account.

In the following three paragraphs we will try to indicate why in our opinion these expectations were not realistic. We will do this by distinguishing in our discussion three levels of experience with, what we call the "traditional TA-concept":

1. The level of TA researchers. Major question: what information can TA research produce?
2. The level of TA researchers and professional policy-makers. Major question: what role do results of TA research play in policy-making?
3. The level of TA researchers, professional policy-makers and stakeholders as well as the general public. Major question: what conditions should TA-information and the "production" of this information fulfil if also the stakeholders and the general public are to consider this information important and are to be able to use it as well,

e.g. in their opinion-forming about or their influence on the policy-proposals which are based on that information.

Thus we distinguish between three important positions in the social network which is of importance to the execution of a TA: researchers, professional policy-makers and the general public or stakeholders. We are fully aware of the fact that in practice one cannot always make a clear distinction between these positions. However, we will adhere to this distinction in what follows, because we think that the positions, even if they are often only ideal types, differ positively, and also because participants in TA-like activities appear to present themselves explicitly as holders of one of these positions.

THREE LEVELS

Level 1: TA as a problem to TA researchers

In the starting years of the TA movement the first of the three expectations mentioned above played an important role. This expectation implied that TA would have proved itself if the possibility of producing reliable and all-embracing information on the future development of a technology and its consequences could be shown. In expecting this, the success of TA was primarily made conditional on the success of TA researchers.

Conclusion 1:

Attempts of researchers to make the future development and effect of new technologies more predictable, e.g. by means of advanced (mathematical) techniques, do not appear to lead to overwhelming results. Uncertainty is inherent in future research; consequently, researchers had better concentrate on the reduction of uncertainty by checking what is known and what is not, instead of continuing their efforts to make the uncertain (future) certain.

During the first years of TA much time and effort was invested in developing and/or modification of a whole series of advanced forecasting techniques. Also a lot of schedules and checklists were published for the design and execution of TA-research (see e.g. Wissema (1977), Armstrong (1980), Jones (1971) and Coates (1976)). TA-projects set up on the basis of this conception were not very successful. Prognoses were frequently attacked and became outdated (e.g. forecasts on the use of energy). Asher (1979), basing himself on experience in the past, finds, together with many others, that by improving forecasting techniques the reliability of predictions need not increase.

Lack of success in this field also appears from research carried out by the Center for Research on Utilization of Scientific Knowledge (CRUSK) in 1978 for the National Science Foundation. On the basis of interviews among users and producers of TA's, about 40 TA's were evaluated according to their usefulness (Berg and Michael (1978)).
This investigation made clear that users had little faith in information generated with the help of modern advanced forecasting techniques (scenarios, forecasting, system dynamics models).
Traditional techniques like statistical analyses, case-studies and cost effectiveness analyses, appear to be relied on more heavily. Users are not primarily interested in predictions; they have a strong desire for identification of the main sources of uncertainty (gaps in knowledge).

Finally, reference can be made here to two articles by George Wise (Wise (1976, 1977)). In these articles, Wise investigates the extent to

which a number of predictions made in the US between 1890 and 1930 on technological development have actually come true. He, too, comes to the conclusion that the possibilities of predicting the future of technological developments are limited. In this connection, he does not expect much from the development of advanced prognostic techniques. According to Wise, the solution has to be sought in an improvement of insight into the (mutual) relationship between technological and social development.

Conclusion 2:

Attempts of researchers to consider all aspects and effects of a technology seem to be doomed to failure. Uncertainty, the enormous complexity of the field of investigation and scarce resources force researchers to limit themselves. This implies that choices have to be made. Since these choices often have a political dimension, it is not for the researchers alone to make them. They should be made together with those people directly concerned.

It can hardly be imagined that it was ever thought possible to chart out *all* effects of a technological development, yet the expectation was created during the starting years of TA that it would be possible to describe *all relevant* aspects. However, the question who was to decide on the relevance of the consequences and whether they should be investigated at all, was rarely stated explicitly. It was assumed that this would become clear during the TA research. The number of TA's however which were not accused of onesidedness can be counted on the fingers of one hand. This is not surprising as the formulation of the research problem is in fact a political issue. Berg (1975, p. 22), verbalizes this political character of TA as follows:

"All the way from the sources of demand of TA to its final outputs, TA is neither valuefree, nor valueneutral, nor non political".

In policy-making circles dealing with TA's more attention is gradually being paid to the formulation of the research problem. Rich (1979), p. 402, observes in this connection:

"Specifically in the case of TA's, reaching consensus on the categories and perspectives to be covered may be more important to bureaucrats than the substance of the information produced".

Level 2: TA as a problem in the relation between TA-researchers and professional policy-makers

From this it may be clear that in our opinion the first (and in a way, also the third) of the formulated expectations have only very partly come true. The second expectation – policy-makers cannot ignore results of TA research and will have to include them in their policies – does not seem much more hopeful; results of TA research are hardly ever used. From the CRUSK investigation mentioned before it may be concluded that also in the United States the influence of TA's on policy-making has fallen below expectations. It also appears that if TA research is used at all, this is done in a way which has no great appeal to advocates of the original TA concept. Thus it appears that:

- Almost the only TA's used are those of which the results are in accordance with the interests of the user, whereas in the traditional TA-concept elucidation of *all* aspects and consequences of a technology was put first.
- TA's are used more often as they provide better insight into specific aspects of the short term, whereas TA's were meant to shed light on a broad range of aspects and were explicitly directed to the long term.

– The need for TA's in policy-making increases as the problem becomes more complex, but on the other hand, their use diminishes as uncertainty about the results of a TA grows.

Conclusion 3:

The discussion about the use or non-use of TA-like information is obscured because "use" is often only thought of as instrumental use, whereas it appears that this kind of information has rather a conceptual function.

Researchers like Caplan (1975, 1979), Weiss (1980), Rich (1979) and Dunn (1980) are trying to find out through empirical research what role information (in particular information which stems from social-science research) plays in the decision-making process.

One of their conclusions (see e.g. Weiss (1980)) is that results of social-science research are indeed used by policy-makers. This may seem a rather paradoxical result, considering what has been said above. For a better understanding, it is necessary to touch briefly on the difference between the concepts of conceptual and instrumental use of information. Conceptual use may be described as the more or less continuous absorption of information resulting in gradual changes of the frame of reference or the mental model of the person absorbing that information.

Instrumental use refers to the gathering of information, starting from a specific problem in order to find a solution for the problem on the basis of that information. Weiss' research shows that information resulting from social-science research is rarely if ever used instrumentally, but very often conceptually. From the reactions of the policy-makers it was possible to conclude that they attach great value to the latter form of information use.

Conclusion 4:

The emphasis on the instrumental use of information is among other things a result of the fact that in thinking about decision-making with regard to technological developments and the role information plays in this respect, people start from a model in which information is almost forced into an instrumental role. It seems more sensible to replace this model by one which conforms much more readily to reality.

This different image of decision-making emerges from the research of, among others, Weiss (1980). Decision-makers appear to deny doggedly that they are continuously taking discrete decisions.

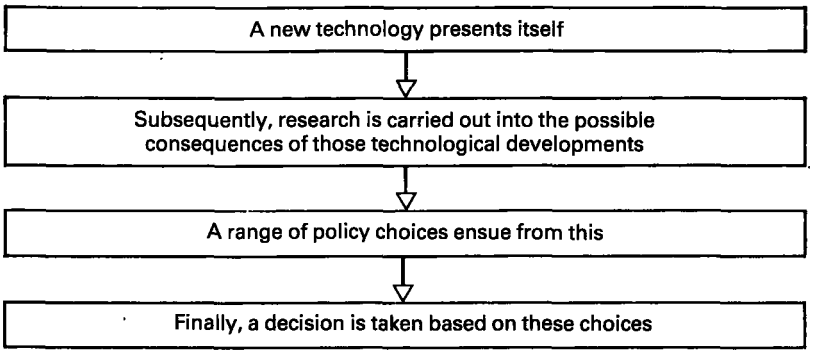
TA information does not play an important role on the instrumental level. The process is not purely rational but often also includes normative aspects. Moreover Weiss shows that the ideal type of a discrete decision, taken by a limited set of actors, is hardly ever met.

Rein (see: Wagenaar en Van Heijningen (1982)) further points out that TA information is only one of the kinds of information playing a role in this process. Thus e.g. information about the – political – support of the different options also plays a part, and – again according to Rein – this part might prove to be of more importance than the one played by TA.

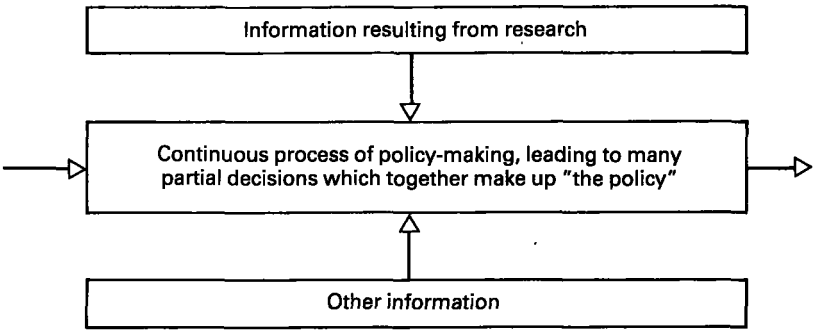
From these and similar research-projects it becomes clear that the image of the decision-making process related to the traditional TA-concepts needs adjustment. The rational, sequential image in which clearly recognizable decision-makers come to optimal and discrete decisions in an almost scientific manner, appears not to be in accordance with daily practice. Research on this practice shows an

image of decision-making resembling a process of negotiation which scientific information, as well as other forms of information, plays an – often even modest – role and in which minor decisions, continuously made by a whole series of decision-makers, together constitute the policy. The differences between the two pictures of decision-making are characterized in the following diagrams.

Traditional image of decision-making



Adjusted image:



The three conclusions (2 up to 4) mentioned above have the following consequences for the relation between research and policy-making (5 up to 10):

Conclusion 5:

The traditional image as drawn in conclusion 4 forces the researcher to provide instrumentally useful information. It seems important to researchers to offer more resistance to this pressure as the possibilities for TA-like research to provide instrumental information are restricted.

Conclusion 6:

In the adjusted image the researcher no longer plays the role of the expert, who indicates which alternatives to choose from, but he will assume the position of the advisor whose task it is to find out what information is needed by those concerned with policy-making.

Conclusion 7:

Research only has a justified function in policy-making if a dialogue is brought about between the world of research and the world of policy-making from which it becomes clear to both parties what the

research is capable of, what information is needed for the policy-making and what role is played in the policy-making process by the information received from research.

Conclusion 8:

The dialogue between research and policy-making should not result in a loss of independence for the researcher.

The dialogue between researcher and policy-maker often appears to be a difficult one. According to the followers of the so-called "Two-Communities Theories" (Dunn (1980), Caplan (1979), Berg and Michael (1978)) this should be attributed to the "cultural" differences between the world of research and the world of policy-making (Berg and Michael (1978), p. 3):

"*The Two-Communities Theories* speak less of blame and, instead, emphasize the existence and importance of the many potential mismatches between the knowledge producing and policy-making activities: differences in language, reward systems, values and goals, methodologies, standards of quality and significance, etc. In these theories the *relationship* between knowledge producer and user is stressed because it focuses attention on the knowledge utilization *process* and on knowledge production and utilization as a *system*".

Advocates of this theory emphasize the need for a better understanding between researchers and policy-makers. The dialogue will start sooner if policy-makers know what to expect from research and if reseachers understand better what the information-needs of the policy-process are and in what way information is used in a decision-making cycle. This theory is the conceptual basis of a great part of the research quoted in this chapter. We consider this research valuable. Nevertheless, a hazardous aspect of this theory could be that the independence of the researcher's position is threatened. Conrad and Krebsbach-Gnath (1980) and Horowitz and Katz (1975) stress correctly that researchers should, in all circumstances, choose an independent position, if only for the reason that a policy-maker can never legitimize his plans with results from studies which were carried out by people who were dependent upon him.

Conclusion 9:

The nature of the decision-making process and also the limited capabilities of research to produce reliable information on future developments makes the pursuit of "once and for all" solutions undesirable. Decision-making should be directed at decisions that leave as many solutions as possible open in the future.

Conclusion 10:

The continuous nature of the decision-making process makes it necessary for the production of knowledge to be similarly organized in a continuous way. An additional advantage of such an organization of the process of knowledge-production is that it is better suited to the limited capabilities available to research to meet the demand for information.

The traditional concept of TA (and the image of the decision-making process that it implies) assumes that there is one point in time, or a very limited number of points, at which policy-makers take crucial decisions for which they would need TA-information. However, we have explained above that decision-making cannot be reduced to a few

clearly recognizable discrete decisions. It should be looked upon as a continuous process in which minor changes of direction constantly result from the minor decisions which, taken together, constitute the policy line.

Level 3: TA as a problem in the relation between TA-researchers, professional policy-makers and the public.

From the preceding it could be concluded that many of the problems with TA (related to its production and use) will be solved when researchers and policy-makers begin to understand one another's options and expectations. This conclusion is premature because it ignores the existence of a third important party: the public.

This public (which could be divided into those directly concerned and the public at large) has clearly shown in the last few years that it is not prepared to accept without question the results of TA-research (or statements of experts) and a policy which is based on or tries to legitimize itself by means of research. This is shown most clearly by the controversy surrounding nuclear energy in which, for example, detailed reports about risks only received strongly negative reactions. This process is not unrelated to the ever repeated demands for greater democratization and decentralization of public authorities.

Also in the field of science and policy we see the demand for participation, the wish to be involved and a strongly diminished trust in experts and policy-makers.

Conclusion 11:

In the decision-making on technological projects researchers and also policy-makers will have to take a more modest position. Feigning certainty in all matters and keeping non-technical elements out of the discussion will in the long run only lead to an intensification of conflicts.

This conclusion is partly a logical consequence of conclusions 1 and 2 in which the restricted possibilities of scientific research in this respect are outlined. It is further supported by the Battelle report (Conrad and Krebsbach-Gnath (1980)) and the work of Nelkin (1977, 1979), Nelkin and Pollak (1979) and Nowotny (1980). In the Battelle-study an effort is made to explain the origin and the persistent continuation of the controversy on nuclear energy. It is put as follows (Conrad and Krebsbach-Gnath (1980), p. 144, our translation S/L/G):

"Public discussion and participation support, to a certain extent, the feasibility of realizing the safety-policy, whereas secrecy causes distrust in situations of social conflict and leads polarization. Therefore the planning and the final choice of sites in particular should not, in spite of the disadvantages connected with it, take place only behind closed doors".

And, (Conrad and Krebsbach-Gnath (1980), p. 142):

"To prevent unnecessary conflicts, keeping back information as well as giving incomplete or "half true" information is to be avoided. In the long run they will only cause an intensification of conflicts. As part of an open information-policy, "partial information" i.e. the state of knowledge together with the relevant point of time, should be published".

From the description of the Austrian debate on nuclear energy by Nowotny it appears that this debate, too, mainly concentrated on the political aspects of the problem and that technical information played

only a minor role. Nowotny also shows that many of the participants seriously doubted the objective character of the information supplied. This doubt was a major element in the debate the more so as it proved to be impossible to involve enough experts known to be opponents of nuclear energy in the discussion.

That knowledge has a political character and is also repeatedly stressed by Nelkin. From her research on a whole series of controversies in which technology is involved, it appears that civilians are very much aware of this political character of knowledge.

Conclusion 12:

With regard to the formulation of the principles of a technology policy and with regard to the problem formulation of TA-like research, a more intense participation of the stakeholders and the general public is desirable.

Conclusion 13:

All people involved in the decision-making process have a right to the information which *they* think is needed. Moreover this information should be available in such a form that non-experts can also handle it.

The last two conclusions are supported by the Battelle-study (Conrad and Krebsbach-Gnath (1980), p. 145, our translation S/L/G):

"Acceptable and defensible decisions on the introduction and use of technologies involving risk can only result from procedures which:
- offer a choice of alternatives,
- are open to social, political and economic arguments,
- encourage participation of interests involved,
- are led by an impartial group,
- aim at a fair distribution of scientific expertise".

We will end this discussion with a Dutch contribution. In his paper "Democracy is too important to be left to technocrats" Jansen finds that if citizens are to have a realistic chance of influence, the following conditions must be met (Jansen (1981), p. 458, our translation (S/L/G):

"- the involvement of citizens in the decision-making from its initial phase;
- decision-making in stages, with repeated public and political discussion on the aims, the means and alternatives;
- decision-making as near to the public as possible;
- always complete, accessible and digestible information;
- insight into the effect of participation and decision-making;
- possibilities of appeal".

3. IN SEARCH OF A NEW TA CONCEPT

It will have become clear from the previous chapter that in our opinion the "traditional TA concept" needs to be adjusted. In this chapter we will outline a TA concept which we believe will remove a number of the shortcomings in the "traditional TA concept" and will at the same time try to take into consideration specific Dutch circumstances. We will do this in three stages. First we will discuss the principles and choices which form the basis of this concept. Particular attention will be paid here to the principles which deviate from those on which the traditional concept was founded.

In the second part of this chapter we will present a formal definition of the new concept, after which we will discuss in the third and final part how this concept can be put into operation.

PRINCIPLES

TA and strategic decision-making

In decision-making on technological developments at the individual, group or organizational/institutional level, at least two levels can be distinguished: the strategic and the operational. At the strategic level the question must be posed what the individual, the group or the organization wants to achieve with a certain technology. This question becomes relevant if a technology is introduced by means of which new possibilities can be realized (television and the ability to transmit pictures almost instantaneously over large distances), an existing possibility can be implemented more easily, less expensively or to better effect (individualization of education by means of the computer) or if a particular technology gives rise to new effects (nuclear power and the problem of radioactive waste). This question also arises if new objectives develop in society which can be realized with existing technology (the saving of energy and microelectronics) or if the appreciation of the effects of already existing technology changes. For example, the labour-saving effect of automation is now regarded in a considerably different light than it was in the mid-Sixties when there were still shortages on the labour market. It is at this strategic level that the principles, objectives and conditions of a technology policy are determined.

The operational level is that of the formulation of concrete policy. As far as the government is concerned, the operational level involves, for example, decisions on purchasing policy, the allocation of finances for research and the ways and means of encouraging and making regulations on certain technological developments. In our opinion TA ought primarily to be directed at the strategic level of decision-making *), **). This opinion is based, among other things, on considerations of a "historical" type. TA was intended from the beginning as a means of obtaining insight into new possibilities and effects of technology. It is not without reason that the term "Early-Warning-System" is often associated with the concept of TA.

In addition, a more pragmatic consideration ought also to be mentioned here. It seems that it is precisely the information at the strategic level that has the most white spots. Although we are not in a position to prove this, we would like to voice our suspicion that these white spots are to be attributed to a considerable extent to the lack of structures within which the parties involved can discuss and consult one another on technology, a deficiency which was also pointed out by the Organization for Economic Co-operation and Development (OECD (1978)).

*) This does not mean that TA is completely independent of the operational level. To a significantly high degree, it are the problems and questions at the operational level which determine the questions to be answered at the strategic level.

**) Directing TA at the strategic level, makes it better possible to determine which subjects come into consideration for a TA. We will give a few examples:

- recombinant DNA: subject for a TA. A new technology gives rise to new possibilities and new effects.
- The introduction of computers in education: Subject for a TA. Not so much because a new objective is being introduced or because it is a question of a new technology, but because the application of this technology in this field can lead to new effects (for example: the effect of automation of elements of the educational process on pupils).
- An industrial island in the North Sea: Not a subject for a TA because attempts are made to realize existing objectives (the extension of industrial areas, the reduction of the threat to man posed by industrial activities) by means of existing technologies.
- The automation of production processes: In the 50's and 60's, labour-saving technologies were welcomed with open arms. This enthusiasm was considerably dampened in the 70's by the rapid increase in unemployment. In view of the fact that this has lead to a societal reassessment of the effects of the introduction of a technology, this is a subject which comes into consideration for TA.

TA information not just from research

Strategic policy with regard to technology requires information of two types:
- Information on the (im)possibilities and consequences of a certain technology: *the technical component* of TA information.
- Information on the way in which the various groups and organizations regard these (im)possibilities and consequences: the *assessment component* of TA information.

The first type of information is provided mainly by scientific research. At the same time, however, we must realize that the problem-formulation for this research cannot be left entirely to researchers. The second type of information does not, in the main, stem from research but from discussions conducted by those involved.

Principles stemming from the analysis given in chapter 2

In addition to the principles explained in the two paragraphs above, there are four important principles which follow more or less directly from the analysis given in chapter 2. It is sufficient here to mention them briefly; for the reasoning behind them the reader is referred to chapter 2. The four principles are:

1. The possibilities of obtaining reliable and "all-encompassing" information on future developments in technology by means of research are limited.
2. TA research (and the use of the results of TA research) is not an objective, neutral or unbiased activity, but is clearly political, and therefore normative in character.
3. The process of decision-making in which TA information is used (or: ought to be used) is not a rational, sequential process in which a number of discrete decisions can be distinguished, but rather a diffuse process of negotiation. The final policy can best be regarded as the result of a whole series of decisions on parts of the problem.
4. During such a process (see 3.) TA information is rarely used instrumentally, that is for the solution of a concrete problem, but it is often used conceptually, that to grasp a new idea or view on a problem or development.

DEFINITION

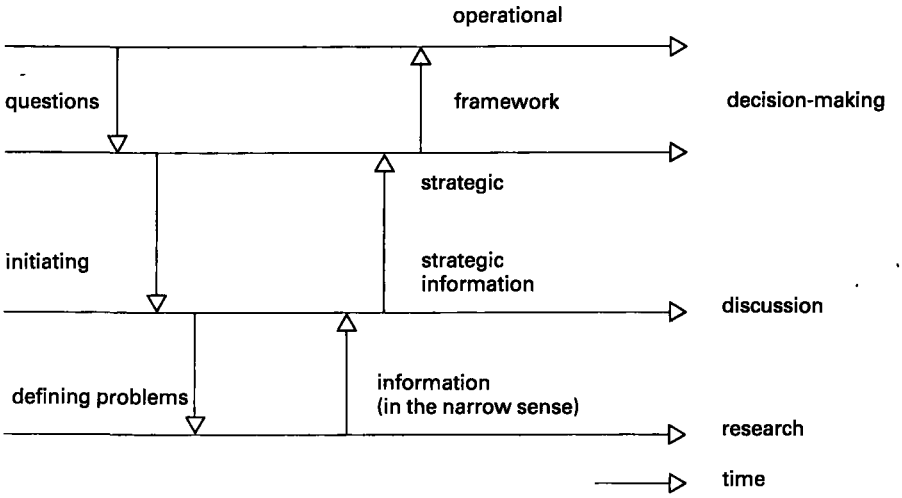
On the basis of the principles given we have defined TA as follows:

"Technology Assessment is a process consisting of *analyses* of technological developments and their consequences as well as *discussions* as a result of these analyses. The aim of TA is to generate information which helps those involved to determine their *strategic* policy towards technological developments and which facilitates the definition of subjects for further TA research".

We assume that there are three important levels for TA activities. These three levels and their relationships to one another have been graphically reproduced in the diagram on page 21.

Before we go into detail on the question of how this TA concept can be put into operation, we will make the following three remarks:

1. It is possible to deduce from the diagram that we also regard the decision-making itself as an element of TA. This is not our intention. We would like to point out here again that we see decision-making (albeit for pragmatic reasons and not for reasons of principle) as a factor to which the TA infrastructure will have to be adapted. The decision-making-level has been represented in the diagram in order to indicate that it functions as a condition for the remaining levels



(discussion and research). This also indicates that TA is primarily directed at the strategic level. With the diagram we are trying to provide some clarity to the relationships between the strategic and operational levels.

2. The diagram (as well as the definition) enables us to reformulate the essence of our argument given in chapter 2. The most important conclusion which can be drawn from the analysis of experiences with TA is that the greatest problems are not to be found at the research level but rather at the discussion level. The discussion level involves questions such as:

- Where and how should the discussion be conducted which must lead to such a problem definition for TA research that it is acceptable for most of those involved?
- What is the relationship between the results of this discussion and the distribution of resources for research?
- What role do the results of the discussion play in the (strategic) decision-making?
- How can it be ensured that new technological and social developments, which necessitate new TA research, are perceived in time?
- How should the problems which arise during discussions between laymen and experts, be tackled?

In order for a TA-infrastructure to function properly, it is essential that answers are found to all these questions for each separate area of technological development.

Supporters of the "traditional concept", however, have concentrated almost exclusively on improving the methods and instruments of research. As we have already mentioned in chapter 2, these attempts were not very successful. This failure can be explained with the aid of the levels introduced in the new TA-concept. Those in favour of the "traditional concept" sought the problems at a level, namely the level of research, where they did not exist and therefore could also not be solved. The reason that they persisted in seeking the problems at this level was a direct consequence of the "traditional concept" in which TA is defined as an activity which takes place exclusively at the level of research.

OPERATIONALIZATION

The above concludes our presentation of the most prominent principles of the "new TA concept". In the following pages we will examine the consequences of these principles for the operationalization of the new concept. We will give attention to five elements:

a. – the definition of the problem,
b. – the advisory role of the researcher in the TA process and the necessity of a pluriform research capacity,
c. – the necessity to differentiate between technologies,
d. – the importance – particularly as far as conducting TA discussions is concerned – of forming links with existing organizations or structures,
e. – it will be argued that it is sensible both from the point of view of finding links with decision-making processes and in view of the limited capabilities of research to cease regarding TA as an incident but to regard it as a process instead.

a. Defining research problems together with those involved

In view of the political nature and the limited capabilities of research, the definition of the problem is a crucial phase in the TA process which deserves a great deal of attention. It ought definitely not to be left to researchers alone. The choice of the problem is very closely connected to the (very often conflicting) interests and opinions of those involved. As a result it is essential that those involved participate in the discussion which should lead to the problem definition.
Naschold expresses this as follows: (Naschold (1970); p. 81):

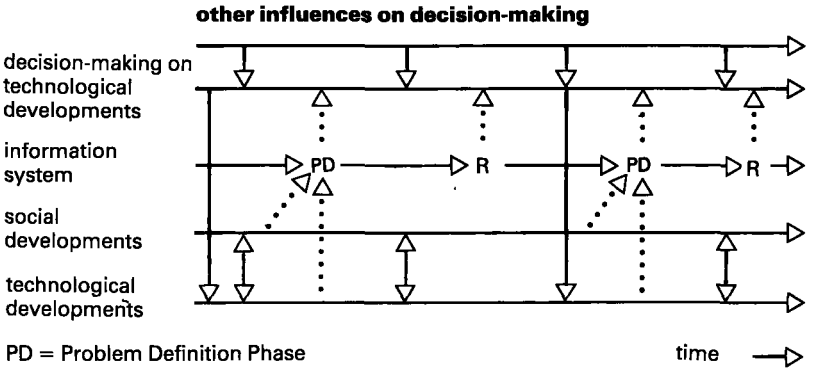
"It must be regarded as a bureaucratic illusion to believe that the interests of individuals in complex organizations in which the members differ socially and ideologically can be ascertained without the co-operation of those individuals themselves". (Our translation S/L/G).

The problem definitions for TA research ought therefore to result from discussions between those involved. In our opinion these discussions can only lead to acceptable problem definitions if the following four questions are raised during these discussions:
1: What knowledge is available at the moment about the technological development and its consequences?
What do we actually know and not know at the moment about the possibilities of the technology, the risks, first, second and higher order consequences, alternatives (including the zero alternative) and future possibilities. Moreover clarity ought to be obtained on the question of the elements of the available knowledge on which there is no satisfactory consensus.
2: What form has the "social map" of a specific technology assumed?
Which individuals, groups and/or organizations are (or soon will be) affected by that technology. What sort of effects does the technology have on those involved (interests, views)? Is there anything that can be said at the moment about future change in this social map which may, for example, be caused by changes in sets of values, causes, or by the fact that new technological possibilities lead to new people becoming involved.
3: What options are available?
Which decisions can be made by whom with regard to the relevant technology in the next five years. In the eyes of those involved: What sort of decisions can be made, which decisions cannot be made. To what extent is the number of options restricted by normative elements and to what extent by uncertainties concerning reliability of knowledge available.
4:Which white spots in the information available can be indicated?
Which additional information is required to increase the number of available options and in whose opinion? About which information is it desirable to gain more certainty in order to reduce the number of conflicts which appear to be primarily related to ambiguity of

information? To what extent is it realistic to assume that the information required can be obtained within a relatively short period?

The answers to these questions will vary as time goes on. This means that answering these questions and therefore also defining research problems is not something which can be done just once. As long as a technological development necessitates this, these questions will have to be raised from time to time.

These repeated discussions are not simply of interest in the definition of relevant problem statements. They also ensure that at regular intervals the question is raised as to whether the group which participates in these discussions ought to be extended. This is necessary because new individuals and/or groups might become affected by the observed development in the technology. This process of alternating between discussion and research has been reproduced in graphic form and shown in its relation to time in the following diagram.



b. Pluriform research capacity and the researcher as advisor

The fact that information often has a political nature which again implies a demand for counter-expertise, leads to the conclusion that a pluriform configuration of research organizations is preferable to a situation in which a single organization gains a research monopoly on a particular area of technological development or (still worse) on the field of TA as a whole. Furthermore it will be clear that the emphasis placed on making an inventory of existing knowledge, the fact that the defining of problems takes place largely outside the research organizations and the limited capabilities of conducting all-encompassing future studies have to lead to the conclusion that the role of researchers in the TA process ought not to be directive but rather advisory one.

c. Differentiation

In the new TA concept a great deal of attention is paid to taking into account the differences between the various situations in which decisions are made concerning technology. From our description of six areas of technological development (Smits, et al. (1984b)), it can be deducted that these differences relate to:

- the technology about which decisions are being made;
- the process of decision-making itself.
- the research-capacity.

As far as *technology* is concerned, the differences concern:

1. The *stage* which the technological development has reached. It

does not seem sensible to discuss *the* stage of a technological development in general terms. A difference has to be made between three processes:

1) the hardware development of the technology,
2) the development of possible applications, and
3) growth of insight into social adaptations and changes necessary for the successful introduction of the technology.

For the TA-infrastructure it is important which phases these three processes have reached, because these phases determine the information which is available, the type of information which is required, the possibility of producing this information and therefore also the TA research capacity required in that specific field.

2. The degree of *relative autonomy* of the technological development. Under certain circumstances a relatively autonomous development may occur. This concept refers to a technological development over which there is a great deal of consensus within the relevant selection environment*), concerning the direction in which the technology ought to or will develop. Whether this high degree of consensus is based on the conviction that further development of this technology will be a good thing or whether it must be explained by a perceived inevitability of the technology (for example because the development is internationally determined), does not play a role here. The degree of relative autonomy is an indicator of the degree of controversy about the development regardless of the nature of the underlying causes. Therefore it is an important factor in determining the kind of pluriformity the infrastructure of TA research has to have.

3. The *diversity* of the technological development (in terms of contributing technologies and areas of application).

Our description of six areas of technological development shows that a process stemming from just one basic technology and having several areas of application in most cases involves "technology push" or technology-orientation. On the other hand, a development originating from several basic technologies and with applications in just one area will often be connected with "demand pull" or problem-orientation. The difference is important to the TA-infrastructure, because it affects the type of information required (technology push requires a more conceptual type of information than demand pull). Secondly, it also bears on the effort required to identify and bring together the parties involved (in case of demand pull this will mostly be easier than with technology push).

As far as decision-making is concerned, the following are important aspects in connection with the need for differentiation:

4. *The actors*

The number of people taking action, the extent to which they differ from one another and the nature of their involvement are all central criteria in the shaping of the TA infrastructure. In addition, the existing degree of communication between the active parties is a relevant condition for the exchange of TA-results.

5. *The institutionalization of decision-making*

It is important for the organization of discussions on TA research and for the formulation of TA problem definitions to know whether consultation structures are already in existence within the framework of which the various people involved meet one another. Also it has to be debated whether the existing institutionalization is still adequate in the light of the new technologies. It is particularly important whether active parties who have not yet found a place with in the formal structure but are nevertheless affected by the new technology, are in a position to exert sufficient influence in the policy-making process.

*) The term "selection environment" has been taken from Nelson and Winter (1977) and can best be defined as the set of factors (economic as well as socio-cultural) which have an influence on a technological development.

6. What *type of decisions* must/can be made on the basis of the TA information still to be produced?

The type of information which must be produced partly depends on which of the following three questions is most strongly emphasized in decision-making:

- Are we going to do something with this technological development?
- What are we going to do with this technological development?
- Who is going to do what with this technology and in which way?

Furthermore it is also possible that the descriptions of these decision-types clarify the extent to which controversy exists and the extent to which this controversy rests on normative factors or on uncertainty about the information available.

Now we come to the *research-capacity* in the specific field. It is obvious that the current state of research has direct influence on the question of which activities have to be initiated to build up a TA infrastructure in that field. The following aspects are of particular importance in connection with this:

7. *Research capacity*:

The pluriformity of research capacity has to be assessed and also the extent to which there exists some form of co-ordination between the various research organizations.

What is the current quality of the research and to what degree are the existing research organizations capable (in a qualitative and a quantitative sense) of answering the current or emerging research questions?

8. *The possibility of producing information*

The possibility of producing relevant information depends, among other things, on the stage which the technological development has reached. If the basic technology is still in an initial stage of development, there is very little point in asking for information on adaptations which are necessary for the technology to be applied successfully. In this respect there is also the problem of secret information and the consequent difficulty of gaining access to some sources of information.

Increasing the understanding of the possibilities of information production, stimulates the realistic and efficient functioning of a TA infrastructure.

d. The link with existing structures

The TA-research and TA-discussions should as far as possible be linked with organizations, institutes and consultation structures which are already in existence in the various fields of technological development. In addition to the pragmatic consideration that this is an efficient way of working, these recommendations are also based on substantive considerations.

Technologies always*) have positive and negative consequences and these are frequently not equally distributed among the various parties involved. Decision-making concerning technology, therefore, just like decision-making in other fields, involves almost by definition conflicts of interest. These emerge most clearly in those contexts (for example works councils) in which the various parties are directly confronted with one another. It is in these situations that one can expect the need for TA information to be the most prominent. That is why it seems logical to link the TA process to situations where these direct confrontations arise. An attendant advantage of this link is that the information which results from TA research is assessed and actively used by (one of) the parties involved, which means that this

*) It is possible to imagine a hypothetical situation in which a technology has exclusively positive or exclusively negative consequences. In such situations, decision-making would not be difficult. As a result, the necessity for information would also not be great.

information will not so easily be ignored by decision-makers as, for example, the information which is produced by an "independent" research organization. A well-known example of such a consultation structure can be seen in the negotiations between employers and employees on the introduction of labour saving technologies (i.e."Technology Agreements").

e. TA as a continuous process and not as an incident

As discussed earlier, TA does not consist of once and for all, all-encompassing research into the future possibilities and consequences of a particular technology.

In the new concept, TA is a process in which research (with limited problem definitions) is alternated with discussions among parties involved on the results of that research. In part, the results of these discussions will have to influence the decision-making, but they will also have to lead to problem definitions for further TA research. This approach is based on the consideration that a process-oriented TA makes it easier to take the limited capabilities of research into account. Moreover, it guarantees a better link of TA with the decision-making process. We will repeat the conclusion drawn in chapter 2 on this subject:

"The continuous nature of the decision-making process makes it necessary for the production of knowledge to be similarly organized in a more continuous way too. An additional advantage of such an organization of the process of knowledge-production is that it is better suited to the limited capabilities available to research to meet the demand for information".

4. THE ROLE OF GOVERNMENT

INTRODUCTION

The role of government in arranging and guaranteeing the working of TA-infrastructures has always been an important topic in the discussions on TA. Opinions on this differ greatly. Some hold that the government should be given an important role, whereas others would like to see TA linked to parliament (see, for example, Enzing (1983)).

Others would prefer an "independent body" (Microelectronics Advisory Group (1980)).

Finally, there are those who find that all this centralization of authority should be abandoned and that instead a fund should be created from which those who claim to need TA information can draw research money, given certain conditions are met (which are unfortunately seldom specified). In our opinion such a definitive choice is neither necessary nor desirable. In the new TA concept, all parties (government, parliament, those involved, researchers) have their own responsibilities. We have already gone into detail about the role of researchers and the people involved. In this paragraph we will turn our attention to the role of the government.

When we discuss the government in this context we are not aiming our comments at all ministries together, but at those sections within the government which deal most with science and technology: Economic Affairs and Science Policy. Moreover, we will restrict ourselves to one specific role of the government, that is that of creator of an infrastructure within which decisions on technology can be made as rationally and democratically as possible.

POSSIBLE TASKS

The creation of a political and financial basis

One task of the government which preceeds all other tasks in this realm is the creation of the political and financial basis necessary to build or to extend the TA infrastructure required in the various fields of technological development.

The White Paper entitled "The Integration of Science and Technology in Society" is the start of the execution of this task.

In addition it is very important to set (and keep) interdepartmental consultation on this topic in motion. Technology crosses over into so many fields that TA infrastructures can only function successfully if they also receive support (and at least understanding) from the ministries which are not so directly involved with technology policy.

Signalling new relevant technical developments

In the preceeding chapters it has been repeatedly emphasized that there should not be one general TA infrastructure, but that the TA infrastructure can best be set up separately for each field of technological development. This implies also that new infrastructures must be created for new technological developments. It is important to monitor which new technologies are being introduced. Moreover, information is needed to assess whether the new technology is sufficiently relevant to justify a new separate TA infrastructure.

The government could contribute to this by creating a "fund" out of which research can be financed, which, in addition to providing information concerning the potential of a relatively unknown technology, would also try to outline the importance of that technology to society. Requests for proposals for such exploratory TA research

would have to be directed especially at the universities and technical universities and at researchers working within laboratories of large industrial concerns. In order to obtain pluriformity and to meet the demand for "counter-expertise" one could consider funding two projects per new technology, preferably differing in their approach.

Encouraging decision-making on the increase (or reduction) of the number of TA infrastructures

It costs time and money to maintain and to allow TA infrastructures to function. Therefore discussions will have to take place at regular intervals within parliament in which sectors the government should continue its involvement with TA. Furthermore, the question whether new technologies are being introduced which require a TA infrastructure will have to be looked into regularly and parliament will have to decide whether this "demand" should be met.

It is one of the tasks of the government to prepare these discussions and to set them in motion. Interdepartmental consultation forms an important part of this preparation, in addition to making up an inventory of the exploratory TA research proposed in the previous section.

Helping to set up TA infrastructures

Setting up, and certainly allowing infrastructures to function in a particular field is a task of the active parties working in that particular field. However, this does not mean that the government should not become involved in this at all. Indeed, during the initial phase, when it is still completely unclear what the possibilities of the new technology are, and the various active parties have not yet been formed, the authorities can play an important initiating role, for example by having research conducted into the social map of the new technology. In order to guarantee pluriformity it would also at this point be possible to have this research conducted by two research groups working from different angles. The authorities can also take the initiative to bring the most prominent and active parties together. A day of discussion between these parties on the social map could form an important contribution to the establishment of a more regular debate among those affected by the new technology.

In addition to a discussion-structure, the research capacity forms an important part of a TA infrastructure. More than once, the existing research capacity in a specific field will appear to be insufficient to answer questions associated with the emerging technology. It will therefore be necessary to carry out a reorganization, reprogramming, renewal and extension or reduction of that capacity. Quite often this will prove to be no easy matter.

The changes which are necessary for a new technology to be introduced successfully are often of a political nature (reallocation of power), and in a sense this is also the case with changes in the research capacity. Research capacity in a specific field is usually a reflection of the political relationships in that field. Because a reprogramming should lead to a research capacity which anticipates the new technologies, reprogramming of that capacity will be politically difficult because this has to happen at a time when the political factions are not yet ready for it. In view of the large part played by the government in the financing of those organizations relevant in this research, the government will also have to play an important role in this recurring process of restructuring existing research capacity.

Keeping the TA process under surveillance

The role played by the government in the supervision of the TA

process is less clear and also more disputed than the contribution by the government in setting up a TA infrastructure.

We believe, with some reservation, that two tasks should be allocated to the government in this respect, namely:

- To assess, with reference to the social map, whether the TA research programme in a specific field meets the requirements of pluriformity;
- To encourage regular research on the perceived social map to see whether it is still up-to-date or whether it needs to be adjusted. Adjustment can be of great importance since it may result in new parties becoming involved in the discussion.

Research and education

Apart from the task of contributing, where necessary, to the building of TA infrastructures in specific fields, the government can also contribute to the development of TA infrastructures and TA research in more general terms. The government can encourage research into the relationship between technological and economic development and into the role of TA information in decision-making on the part of individuals, groups and organizations.

Finally, we would like to point at education. If we want to ensure that scientists and engineers become somewhat more receptive towards TA information, then more attention has to be paid to TA in courses at institutions of higher education. It is one of the tasks of the government to find out how this can be realized.

Conclusion

Now that we have reached the autumn of 1984, the time has come to await the outcome of the Dutch parliament's treatment of the White Paper entitled "The Integration of Science and Technology in Society".

It is only when parliament has accepted the White Paper that TA in the Netherlands can actually begin to be developed further. We await this parliamentary treatment of the White Paper with optimism. It seems inevitable that parliament will ask the government to make more rather than less money available for TA.

In view of these positive prospects, the Directorate General for Science Policy has considered it justified to commission STB-TNO to carry out subsequent research. During this research a start will have to be made with the actual start of TA in a limited number of fields of technological development. The intention is that these should be the medical and production technologies. During this subsequent research, the ideas which were developed in the more theoretically oriented first research project (with which this report has been concerned) will actually be tested in practice.

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