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Rationalization or reflexive scientification? On the debate about the functions of technology assessment for technology policy

Preliminary remarks: The boom and criticism of a label

In the twenty-odd years of its existence, "technology assessment" has had many children – with changing partners. Technology assessment (TA), technology research, or constructive TA have enriched the spectrum of relevant hybridizations, especially in recent years. However, this seems to be due less to plurality than to arbitrariness. Elementary terms are recombined in every conceivable way and given attributive definitions. The recently launched "ex-post technology assessment" could be seen as a temporary crowning achievement, creating a smooth transition to technology genesis research (Gloede 1991).

If we examine the current debate on technology, technology research, and TA more closely, we can make the diagnosis that "the 1980s reinvented criticism of the TA paradigm once again" (see Petermann [1992] in this book). The fact that today more participants and communities have entered the arena of technology science and technology policy controversies than in the 1970s does not sufficiently explain the "retreading" of arguments. Rather, unresolved and unsolved problems of technology development and technology policy regulation still seem to be responsible for this.

The first indications of this thesis can be found in the self-referentiality of many criticisms of the concept and practice of technology assessment. They ignore the relationship between TA and its social framework conditions and concentrate on the scientific deficiencies of the concept, which can only be remedied through basic disciplinary research or through a TA concept of the nth generation. The subsequent articulation of the need for research and funding is openly self-referential. In this way, the critique paradoxically participates in the boom of the criticized label without referring to the problems and possible solutions of the subject area in a comprehensive way.

Before we break the baton in this way about technology assessment as a "strategic framework concept" (see Paschen & Petermann [1992] in this book), it seems appropriate to take a look at the "classical" TA concept against the

background of the political perceptions of problems at the end of the 1960s and the beginning of the 1970s. The dilemmas of this TA concept are – it should be made clear – to a large extent a reflection of the ambivalence of state technology policy (Sec. 1). The "new" TA concepts either ignore these correlations or fail to provide a fundamentally new solution (Sec. 2).

However, if the contradictions of social technology policy cannot be resolved at the level of a general TA concept, the question of the conditions and reasons for the practical continuation of technology assessment becomes all the more pressing.

A programmatic plea is made for TA to be recognized as the subject and object of a "reflexive scientification" (Beck/Bonß 1989, p. 29). In this perspective, reflective and self-reflective technology assessment has a strategic character both cognitively (as produced knowledge) and institutionally (as an actor in the technology policy arena) (Sec. 3). Some implications of this (self-)understanding are then outlined. From a cognitive point of view, the consequences that a conceptualization of the subject of TA should have for the implementation of TA studies will be discussed (Sec. 4). Finally, from an institutional point of view, some conditions for the realization of reflexive technology assessment with strategic intent will be addressed (Sec. 5).

1. The "classic" TA concept and its dilemmas

1.1 Problem-oriented research and the genesis of the "classic" TA concept

The concept and institutionalization of TA in the late 1960s and early 1970s were part of a general upswing in "problem-oriented research" (de Bie 1973; cf. also Lohmeyer 1984). The problems of problem-oriented research already discussed at that time were very similar to those of TA institutionalization. Parallels can be found down to the last detail if we take, for example, "social indicators" research (Bechmann 1976) or policy research in program and practice (Ukeles 1977; Jann 1985).

Problem-oriented research with the intention of providing policy advice must be understood as an expression of the political system's specific perception of problems. Thus, the TA concept did not originate as an offer from the sciences to politics, but was developed by politicians in conjunction with policy-oriented advisors (Dierkes 1987a, p. 191). In this context, it was noted early on that the label of *technology* assessment in the U.S. was actually intended to describe an assessment of *political programs*, i.e., specific policy research rather than (a new

form of) technology research. In the German reception, on the other hand, the focus on technology seems to have been decisive from the outset. The dominant orientation in the 1970s toward "technology policy as active structural policy" (Hauff/Scharpf 1975) on the one hand and the experience of initial conflicts over major technical projects on the other may have been responsible for this.

There are many problems, but very few of them are recognized by the political system. Possible selection criteria are those that in one way or another indicate a threat to the existence or functioning of the political system.

Crises, such as reproduction crises, control crises, legitimation crises (Habermas 1981, Vol. II, p. 364ff.), not only represent problem pressure and a need for action for the political system. If they appear to be sufficiently serious, they are indications for the political system that established social and political forms of regulation, which are normally intended to and actually do manage "disturbances" and conflicts, are inappropriate, or no longer sufficient (Dierkes 1987a; Dierkes et al. 1988).

This is always the hour of scientific policy advice. The development of the TA concept was not only about researching the development conditions and control problems of technologization, but also about making a virtual contribution to *changing or supplementing* the coordination of social action and political decision-making procedures.

In general, many concepts of problem-oriented research were based on two fundamental assumptions:

- There is no alternative to technical-industrial modernization. Reproductive disorders and crises are not caused by internal contradictions, but by the "wrong" treatment and care of the "cow that you want to milk" (Willy Brandt). At the core of these ideas, industrial society appears as a (highly networked and complex) "machine" that needs to be "controlled."
- The sheer extent of technologization and scientification of society means that the production of suitable control knowledge is required for control purposes. And since it is about society as a whole, scientific and technical knowledge must be supplemented by human and social science knowledge – widely understood as "social technology" (Beck/Bonß 1989, p. 8ff.).

Basic assumptions of this kind also shaped the early TA concept (Wynne 1986; see also GW 1975). Science and technology as axial principles of society were to find their equivalent in the production of political control knowledge in order to bring about "rational" decisions. This almost inevitably closed the technocratic circle.

The tasks of TA formulated at that time show what qualitative progress was to be made compared to conventional (predominantly disciplinary) policy advice:

- Completeness of the analysis with the aim of taking into account previously unnoticed correlations and, accordingly, interdisciplinarity in the *factual dimension*;
- Early warning for the purpose of anticipatory consideration of problems that would otherwise be perceived "too late" and therefore concentration on "consequences" in the *temporal dimension* that are not immediately recognizable;
- Comparative evaluation of technologies or options for action (possibly with the participation of those affected) to maintain consensus or to reach compromises in the *social dimension.*

This phase can be characterized as a "simple" as opposed to the "reflexive" scientification (Beck 1986, p. 259). In any case, politicians and scientists alike rhetorically shared considerable expectations regarding the certainty of the forecasts and evaluations to be obtained in the context of an "instrumental-technical knowledge" paradigm.

The further course of "rationalized" modernization of industrialization and technological development showed that the underlying assumptions of the concept were fragile. The economic cycle could not be "shaped" without crises, environmental destruction remained a pressing problem, and social and political conflicts were not resolved. Problem-oriented knowledge was neither "instrumentally" successful nor context-independent in a technical sense, but was highly open to interpretation and therefore controversial.

This experience can be seen in attempts to reformulate the TA concept (Menkes 1983; Paschen et al. 1978). A more instrumental concept became a more strategic one, the need for selection and scoping was emphasized over the claim to completeness, and one-off scientific efforts became an iterative and recursive "process." The institutional history of the OTA can also be interpreted as a process of pragmatic adaptation – from a primacy of politics via a primacy of science to an unstable balance between science and politically controversial factions.

Nevertheless, considerable discrepancies remained between a pragmatically reformulated "strategic framework concept" and the practice of TA.

1.2 Ambivalences in technology policy and the dilemmas of TA

The historical reconstruction of German research and technology policy from the post-war period through the phase of planning and reform euphoria to the programmatic return to a "reactive" technology policy (Briefs 1991; Stegmüller 1990) reveals two fundamental contradictions:

- Although state research and technology policy (similar to industrial and infrastructure policy in general) is based on deficits in the self-regulation of the market economy system, it must not run counter to its logic for structural reasons.
- Their orientation toward the logic of market processes and capital accumulation creates – in relation to controversial social interests and needs – a specific weakness of legitimacy, which is confronted with an increasing need for public legitimization due to growing funding measures (Urban 1982).

As a consequence, this constellation means that politics must also legitimize such technical developments (or deal with their "consequences") that it has neither initiated nor can significantly influence (Fach/Grande 1988, p. 385).

The contradictions in the relationship between the political system and its environment correspond to internal contradictions. In fiscal terms, for example, a dilemma arises from the state's interest in promoting growth because of the tax *revenues* that depend on it and the state's fear of the "consequences" of growth because of the tax *expenditure* required for repair and compensation services (Ullrich 1988), for example in the form of the problem of contaminated sites. In terms of legitimization policy, on the one hand there is the insight to withdraw the exaggerated claim to political omnipotence (Engholm 1988; Momper 1989), on the other hand the obvious withdrawal of general responsibility rhetoric (Beck 1988) clashes with the functional imperative of securing social reproduction. The fact that "politics" is also and above all made outside the political system and leads to a "dissolution of boundaries" of social subsystems (Beck 1986, p. 300ff.) raises problems of continuity. On the one hand, environmental complexity and problem networking suggest overarching internal coordination of the political system, but on the other hand they are counteracted by – also functional – segmented processing and small-scale working structures.

Summarizing the observable contradictions, this results in fundamental ambivalences of the political-administrative system toward TA as problem-oriented policy advice.

From a factual point of view, the political system ultimately expects scientific advice to ease the burden of identifying problems and the need for action. Hete-

rogeneous information should be organized, evaluated, and external demands on the political system reviewed. However, in view of the problems and issues that TA has to deal with and which it can only process as "interpretative" research, it usually fails to meet the expectation of reducing complexity. In contrast to technical instructions, it does not lead to easily manageable recipes, but rather to an increase in choices and future options (Luhmann 1990, p. 634; cf. also Beck/Bonß 1989; Weber 1989).

In terms of timing, the ambivalence of the need for advice is reflected in the fact that scientifically reliable information is expected at a time when problematic developments are not yet apparent, i.e., when the political system does not yet have an immediate need for action. It is precisely for reasons of research methodology and pragmatism that it is not possible to provide unambiguous indications (which are intended to facilitate or replace political considerations and decisions).

Finally, *from a social point of view,* political decisions are expected to be scientifically legitimized and made more "acceptable" through consultation. However, it is precisely the increasing scientification of social action and decision-making processes that has contributed to the dismantling of scientific authority (Weingart 1983). Even scientific-technical knowledge does not appear in a specific sense to be free of values and norms, but rather characterized by decisions and choices in several dimensions (Beck/Bonß 1989, p. 16f.; cf. also Halfmann 1988). It thus became increasingly clear to TA that the political consensus it was supposed to create was basically already a prerequisite (Wynne 1975).

These ambivalences can easily be found in the obvious contradictions of political rhetoric on TA. Here we need only refer to the "parliamentarian's fear of dealing with science" (Petermann 1988), which presents itself as a fear of technocracy and a defense of the primacy of politics. This is certainly based on fears of a loss of power and pragmatic restrictions on parliamentary work. But how is the articulated fear compatible with the simultaneous demand for "hard," unquestionable, instrumental knowledge, which is supposed to reduce uncertainty and complexity, and marginalize "soft" knowledge (such as that of the social sciences)? (Beck/Bonß 1989, p. 19). The political approach to scientific advice can only be understood from a "rationality" of the political, which – in contrast to science-centered assumptions – is highly contradictory in itself.

The contradictions of state technology policy outlined so far and the ambivalences of political expectations of TA are ultimately reflected in dilemmas and practical deficits of the TA process, which can only be understood with some blindness as those of a pragmatically reformulated TA *concept.*

If, for example, the "steering dilemma" of TA (Collingridge 1980) is seen in the fact that TA studies come either "too early" (due to unsolvable forecasting problems) or "too late" (due to irreversible social consolidation of a technological development), both the cognitively irreversible social framework conditions (Wagner-Döbler 1989, p. 177) and the ambivalence of instrumental consulting expectations in factual terms are addressed. The "implementation dilemma" (Paschen et al. 1992) between an orientation toward traditional "scientificity" without practical relevance, and an orientation toward concrete addressee premises without the prospect of acceptance of the results by other social actors, obviously paraphrases the aforementioned ambivalence of political expectations in social terms.

Such dilemmas cannot be negated by a reflexive TA concept, but from this perspective they appear in a new light. At the same time, they indicate boundary conditions and requirements that the criticism of "classic" technology assessment must face just as much as the proposed "new" concepts.

2. The "new clothes" of TA: Scientism, normativism, pragmatism

In my opinion, more recent critiques and counter-concepts of TA all too often miss the constitutive connections that exist in the relationships between problem situations and social perceptions of problems, between the political system and its environments, and between problem-oriented research and its "embedding." Sometimes the focus is only on the scientific quality of TA (scientism), sometimes the institutional deficits and limits of state policy are blamed on the TA program (normativism).

2.1 Scientism

It is typical of a "*scientistic*" criticism of TA that the "control dilemma" or the "forecasting problem" (Frederichs/Blume 1990) are *reduced* to "basic methodological problems." The "aggregation problem" (the relationship between national accounts and the operational "realization" level) also appears to be one that can be solved through scientific creativity, instead of seeing it primarily as a systemic problem of market-based self-management in relation to political global management.

Naschold notes a "standard reaction" to this view: the "relegation of such problems to the processing routines of the scientific system" (Naschold 1987, p. 17; cf. also Beck/Bonß 1989, p. 21). Since the scientific system is necessarily overbur-

dened with such impositions, the scientivist critique is radicalized to the effect that TA cannot fulfil its claim to scientificity. The traditional boundaries between science and politics are called into question. This has two possible consequences:

- either the general renunciation of TA
- or the return to a decisional advisory concept.

The *general renunciation* of TA can take on several shades. On the one hand, we find tactically motivated pleas (Radaj 1988), which are actually concerned with preventing the public politicization of state technology policy – for example through TA capacity in parliament (Meier 1987).

Not for a second would most representatives of this position advocate a waiver of consulting and planning at company level.[1]

On the other hand, we find pleas for a retreat into the academic ivory tower, which refer to unresolved questions of disciplinary research, but in fact rather deal with disappointments about the "implementation dilemma" (von Thienen 1989; Knie 1990). What usually remains unreflected is their own science-centered understanding of practice and a concealed technocratic way of thinking, which considers scientific rationality to be the only "true" one and has long since left its future behind with the phase of planning euphoria (Beck/Bonß 1989).

The *return to a decisionist consulting concept* is demanded when the specific problems for TA are denied and reference is made to "controllable boundary conditions" of positivist science (Pinkau 1987).

Without repeating the criticism of classical decisionism (Habermas 1964) at this point, it is only necessary to refer to its current socio-political significance.

Its first implication *programmatically* amounts to the re-segregation of social subsystems from one another and is thus directed against a "dissolution of political boundaries," which Beck and Eder adequately consider to be a "risk society" (Beck 1986; Eder 1988). No matter how one judges such diagnoses of the present, the decisionist plea today certainly represents an expression of crisis warning and

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1 Incidentally, a comparison between business-related and policy-related consulting is a good way of illustrating the nature of the supposed cognitive and conceptual dilemmas. (Coates/Fabian 1982a; Evans/Moussavi 1988). Under the premise of relative homogeneity of interests in individual companies and limited planning horizons, the strategic character of scientifically supported planning is accepted. Conversely, the well-known controversies about the meaning of risk analysis arise when actuarial and decision-theoretical concepts are transferred from the corporate sector to the socio-political sphere (Beck 1986; Evers/Nowotny 1987).

regulatory roll-back. In other words: the established modes of regulation (Dierkes et al. 1988) are (once again) considered sufficient (Evers/Nowotny 1987, p. 325).

Its second implication amounts *ideologically* to the wish for a restitution of scientific authority, whose statements would have to be valid ex cathedra (or ex Berlin) (Becker 1989; Gloede 1991). Although this wish is understandable from the point of view of established scientists and politicians in need of legitimization, it cannot even be fulfilled at Christmas (Weingart 1983; Beck 1986).

Its third implication *practically* amounts to an anarchic pluralism of scientific assessments, which conceal basic disciplinary assumptions and also very personal evaluations, are likely to correspond to complex problem contexts only by chance and would be just as functional for politicians seeking advice as an informational chaos – i.e., depending on the situation, either paralyzing or extremely helpful (Britsch 1989; Rasehorn 1989; Rautenberg 1989; Schatz 1989).

2.2 Normativism

The second fundamental line of criticism relates to the TA concept, which is accused of lacking problem adequacy (reified concept of technology or technology determinism) and incorrectly limiting itself to "consequences," when it is at least as important to analyze the conditions under which they arise.

This is usually followed by the argument that TA should be replaced by technology design, innovative or normative technology assessment, or even ethics (Ropohl 1985; partly also Fricke 1989; Lohmeyer 1984; Reese 1986).

It only seems plausible at first glance that this *normative criticism* of the TA concept is due to new scientific findings. Rather, the "discovery of the formability of society" (Evers/Nowotny 1987) and technology should be seen as the result of the crises and conflicts from which TA ultimately arose. Radkau has aptly pointed this out (Radkau 1988).

It thus becomes clear that normativist concepts tend to substitute science with politics (or social decision-making). This is illustrated by Meyer-Abich's concept of socially acceptable technology design as an answer to the question of "how we want to live in the future" (von Alemann/Schatz 1986; Bechmann/Gloede 1986). Ultimately, it is scientific elites who decide instead of (or even before the eyes of) the public where the journey should go (Evers/Nowotny 1987, p. 259ff). Philosophy in particular has recently discovered a long-missed area of business when it includes in its offerings overarching rationality criteria for the development of technical knowledge (Spinner 1989), professionalized ethics

(Zimmerli 1982), or even just the "rationalization of the obscure" (Gethmann et al. 1989[2]).

In their desire for a "rationalization" of the purposes of technology development and technology policy, the normativist concepts have technocratic implications. At best, they appear promising in the area of "interpretation" and "symbolic mystification" (Beck/Bonß 1989, p. 22). Their more or less hidden promises of public acceptance through "acceptability criteria" are open-ended.

However, they will certainly fail as *concepts* in practice if they lead to a change in real social and political forms of regulation. It is doubtful that companies will voluntarily cede decision-making authority to philosophers or technology evaluators. It is counterfactual that the political system is prepared to restrict the decision-making freedom of private economic units beyond the usual level (regulatory standardization) on a case-by-case basis (Traube 1988, p. 25f.). Finally, the hope for a change in awareness among engineers (via VDI) is also likely to be deceptive. All relevant studies in the past and present show that the influence of moralizing discourses remains marginal (Kohlstock 1991). At best, a certain influence arises from socially consequential conflicts in that it is not the morals of normativists but the heterogeneous values and interests of the public that become practical. In this roundabout way, normative shifts also penetrate companies – but slowly, very slowly (Coates/Fabian 1982; Evans/Moussavi 1988).

Recovery research, insofar as it does not operate exclusively within a disciplinary frame of reference, also falls victim to this verdict. Dierkes' concept of "Leitbild-Assessment," which at least attempts to build a bridge between "exciting" research and political problem perceptions (Dierkes 1987b; Dierkes/Marz 1990), is subject to two errors:

- It spreads illusions[3] about the influence of entrepreneurial or technical models on the ecological and social qualities of diffusing technology. Later

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2 *Editors' note*: No bibliographic details were provided in the original publication.

3 In the first instance, Johannes Cross can be considered an unsuspicious witness: "The people who allow themselves to be celebrated as managers never talk about how they manufacture or sell a product, but about the philosophy on which they base themselves and their company" (FAZ-Magazin, December 1989). While the idea of "Leitbild-Assessment" was originally more in line with the postulate of early political influence on technology design (without, of course, having recipes for influencing mission statements in good time), today the virtue of "soft" social action coordination seems to have been made out of hard control theory necessity (Dierkes/Marz 1990, p. 39ff.). However, the arguments that guiding principles of all things could be promising for steering remain just as soft as the steering itself is recommended to be. On closer inspection, this

implementations and their consequences cannot be adequately deduced from the intentions of very early innovation activities. As empirical genesis projects show, these often break with social and political configurations (HACK 1988, 1989). The resolution of the Collingridge dilemma, as can be seen here again, is not scientifically feasible (Wagner-Döbler 1989, p. 149).

• In this respect, as with all normativist concepts, a fundamental insight that was already the inspiration for TA is ignored here: namely that intended purposes and measures can certainly have unintended "consequences." From this perspective, "finalized" science and technology development on the one hand and TA on the other represent complementary tasks (Rammert 1990, p. 347).

2.3 Pragmatic mediations

After scientism rhetorically sought to grant primacy to politics and normativism (with its technocratic implications) to science, we must now turn to the third perspective, which cannot be absent from the classical triad. *Pragmatic critique or TA concepts* of younger "generations" are based on a discomfort with the lack of consequences of impact assessments and explicitly reflect the practical experiences of past TA. However, in their criticism of the concept, they tend to refer to the old technocratic self-image (Rip 1987; Smits et al. 1987; Smits/Leyten 1988), which they contrast with a process-oriented concept that mediates between research, politics, and society. Many of the postulates mentioned here have long since been adopted by the classic TA *self-image*. This also applies to the "dragged along" claim to participatory TA (Naschold 1987).

However, it is precisely where the boundaries of traditional political responsibilities are to be exceeded in two respects (Schuchardt/Wolf 1990), namely by extending TA into the operational and social space as participation in "decentralized design" and by extending the participation of social actors in political TA – Naschold calls these "extra-paradigmatic" developments (Naschold 1987) – that the new pragmatic concepts come up against the very socio-structural and regulatory limits to which the reformulated TA concept also finds itself exposed. The *practice* of such concepts – be it "constructive TA" (Smits/Leyten 1988) or socially acceptable technology design (von Alemann/Schatz 1986) – is in fact

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perspective is related to the radius of action of the creators of "organizational culture" (Dierkes/Marz 1990, p. 38) – which ultimately brings us back to Gross' scepticism.

subject to very similar restrictions. Without any malice, reference must be made here to the resistant conditions of good intentions.

Perhaps a more important aspect is the appropriation of operational mechanization and rationalization processes for TA. Here, too, scientific advice and support are only as effective as the respective interests and power relations of the participants allow. Trade union co-determination in the implementation of technology is still largely in its infancy (Briefs 1991; Weber 1986).

As much as the "extra-paradigmatic" inclusion of non-political areas in TA concepts could be programmatically in line with the trend toward social self-regulation of formerly "political" issues (Fach/Grande 1988, p. 385), two things must be pointed out:

- On the one hand, operational mechanization or technology design is usually a level in which "scope for design" is only given in relation to a basic technology that has already been introduced into society. In this context, the "designability" of technology, which is also a popular political claim, often conceals basic decisions that have long since been made, and structural rigidities (Hack 1988). The classical TA concept, on the other hand, is concerned with more fundamental problems of technologization that require general regulations.
- Secondly, the company level is not necessarily the place where the social actors involved are willing or able to assume "social responsibility" beyond corporate egoistic concerns. There is ample evidence of this (Coates/Fabian 1982; Evans/Moussavi 1988).

As long as new forms of mediating "decentralized" and "centralized" decision-making processes are not available, the political system in its function of framework regulation and global control hardly seems dispensable (Coates/Fabian 1982, p. 340). This is also the point of fundamental criticism of the decentralization and proceduralization discourse (Evers 1989; Seibel 1985; cf. also Dimmel 1989).

In my opinion, the new "pragmatic" TA concepts outline three interrelated aspects more clearly than was the case with the classic concept:

- the procedural character of TA processes as a scientifically mediated process of understanding and negotiation (Rip 1987),
- the necessary "strategic" or "communicative" character of TA knowledge in the context of such processes (in contrast to an "instrumental" or "science-centered" understanding of rationality) (Beck/Bonß 1989, p. 24ff.),
- the participatory structure of TA processes (Naschold 1987) as a necessary – not sufficient – condition for their virtual consensus-building function (in-

stead of acceptance studies in the context of "realization conditions" (Gloede 1987).

It remains to be seen which general "target system" (Böhret/Franz 1982, 1985a) will prevail as a result of social conflicts and power relations: whether the "maintenance of a generally acceptable technological and social change," or "the socially adequate regulation of technological change."

This openness of the TA concept, which does not apply equally to all aspects of the TA process, can perhaps even be regarded as one of its advantages (Conrad 1981).

3. Reflexive scientification and TA

After the overview given so far, it is no longer sufficient to simply fall back on problem perceptions of the political system in order to reformulate the TA concept.

Since almost all attempts to play off good "ideas" against a bad "reality" have failed historically, a self-enlightened TA concept must refer to the relationship between objective problem situations and political-social problem perceptions in a doubly reflexive way.

- At the level of *problem situations*, it can be assumed on the one hand that there is an objective substrate of natural processes or natural social processes whose characteristics and "consequences" are perceived by social systems (Landfried 1991, p. 104f.). From this point of view, the processes appear to be the most powerful opponents of themselves precisely in their naturalness (Beck 1988).
  On the other hand, however, there is no way around social and political perception if developments are to be controlled or shaped in a reasonably conscious manner. This also and especially applies to programs that seek a new "balance" between society and nature (Sieferle 1989, p. 193ff.).
- At the level of *problem perceptions* (which are mediated by social conventions and negotiations), any concept formation cannot therefore start naively from those problem situations, but must be based on a process of perception which – as indicated – is contradictory and fractured *in itself*.

TA as a program must focus on those contradictions within the political system and its environments that are both an expression of problem situations and indicate their modes of processing.

With regard to solving "factual" problems, TA can tie in with general efforts to ensure social reproduction. Such problems (such as the global climate) induce a dynamic that makes established reactions and regulations appear contingent or malleable (Böhret 1990, p. 260ff.). Despite the continuing context dependency of specific problem perceptions, mediating "themes" of social communication emerge here, which can be connected to (Luhmann 1990, p. 639).

With regard to problem perceptions *within* the political system, which are a direct point of reference for TA, it can reliably rely on the political system's interest in itself, which creates starting points for *options* for change even without normativist utopias.

It should have become sufficiently clear that, from this perspective, the hope of a standard line from "scientific rationality" to political decision-making is misguided. Rather, in its relationship to politics, TA is referred to complex strategic "games" that take place within the political system as well as in its environments (Beck/Bonß 1989, p. 30ff.). It should also not be deceived by supposedly sober self-assessments of internal actors who only consider a TA reception possible if the results confirm decisions that have already been made (Gries 1991; cf. also von Thienen 1989, p. 44). This is generally part of the game, as the results of social science research on utilization suggest.

If the diagnosis of strategic "games" between social actors in political arenas is correct, if these also characterize the handling of problem-oriented research, then TA itself must understand itself strategically in two ways:

- as a producer of "strategically" oriented knowledge[4], which is inevitably knowledge for action and sees its conditions of validity influenced by its use (Wingens/Fuchs 1989, p. 218);
- as a participant in strategic games, whose specific perception of problem situations and self-interests (as research) is functionally necessary (Lau 1989, p. 412ff.).

Public reflection on this function of TA could also increase the credibility of expertise in social discussions. After all, scientific policy advice is seen as compe-

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4 Although arguing similarly in substance, Rip cites the term "strategic use" of TA results with a different meaning – namely as selective use to legitimize political decisions that have already been made (Rip 1987, p. 165). The corresponding counter-concept – "substantial use" – shows that the distinction adopted by Whiteman is largely based on scientistic premises (of one, "substantial" rationality). However, Rip correctly recognizes that "attempts to prevent strategization" in fact lead to a reduction of learning effects in social conflicts (Rip 1987, p. 166).

tition in the struggle for power anyway (Mayntz 1983; von Thienen 1989, p. 43). The corresponding mistrust cannot be dispelled by assertions of a scientistic self-image.

There are some indications that the renunciation of an instrumentalist self-image of TA called for here and also invoked elsewhere need not remain a pious wish. At the European Commission (EC) level, for example, it is at least proclaimed that one cannot wait until there is certainty about the validity of one or other global climate forecast (Hasselmann 1990). In the reformulated "classical" TA concept, conditional forecasts are increasingly being replaced by the formulation of political options by relevant decision-makers, whose "impact assessment" (e.g., with the help of constructed scenarios) is not measured by the certainty of their occurrence, but primarily by the structural/qualitative implications of a comparative consideration of those options (Paschen 1992, Böhret 1990, p. 179; cf. also Frederichs/Blume 1990, p. 26ff.). *Every* subsequent decision (which is made within the horizon of what is desired, of the probable implications, of what is possible in terms of power politics) already changes the basis of the previously constructed scenarios. Even if the TA studies understood in this way only (should) offer "orientation knowledge," a political discussion of their results may shift accents, change justifications, or open up new possibilities. Even on this rather "immaterial" mediation path, the social development and decision-making conditions do not necessarily remain the same (Beck/Bonß 1989, p. 27ff.; Roßnagel 1989a, p. 51).

In my opinion, the implicit "forecasting burden" (Paschen 1992) that still exists with such an approach takes on a different status. Certainly, even if it is not a matter of predicting the future, but of a "critical examination of future wishes" and the identification of starting points for political action (Roßnagel 1989a, p. 51), justified assumptions must be made about the connection between action goals, boundary conditions, and possible "consequences" of action, which can include causal relationships in the subject area of the options analyzed[5].

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5 The most tangible reversal of questions of social communication processes into those of objectifying analysis (with the corresponding "forecasting problems") seems to me to be the consideration of society's future values in TA studies. In fact, such values can change "unexpectedly," and this in turn could be of some interest for an anticipatory consideration of the consequences of political decisions. However, in view of countless complaints about the – problem-related – inadequate time horizon of political calculations (legislative periods!), this uncertainty appears to be of little practical relevance. The postulate of a prognostic inclusion of value change processes becomes completely absurd if it serves to declare political decisions illegitimate according to *today's* value standards as long as no statements can be made about future ones (critical: Tribe 1973).

However, the "uncertainty" of such assumptions *no longer* appears here *primarily* as a *limitation of knowledge*, but *rather as a problem of understanding* between the actors involved in the TA process (including the TA researchers) about the possibilities and problem adequacy of scientific operationalizations (Frederichs/ Blume 1990, p. 32ff.; Landfried 1991, p. 96ff.; Rip 1987, p. 168ff.; Roßnagel 1989a, p. 52).

Such a "strategic" turn in the pragmatic (self-)description of TA is further supported by the results of eco-systems research, which in perspective no longer allows even the most hard-nosed decisionist to claim causally fully determined prognoses (Halfmann 1988; Frederichs/Blume 1990, p. 38ff.). At best, individual aspects of development and "impact" assessments – such as the results of sub- stance-related impact research – can still be examined in terms of a positivist understanding of science (Wagner-Döbler 1989, p. 145). Overall, however, state- ments generated in this way by those involved (science, politics, society) are always in need of interpretation. In my opinion, such a perspective should be rep- resented offensively instead of defensively conceding the limitations of knowledge.

The problem- and practice-oriented reflexivity of the TA concept should be accompanied by actor-oriented reflexivity. In direct discussions with addressees and, above all, in public discourse, it should be made clear where the virtual benefits of strategically understood TA could lie for individual users and for social development as a whole. The accusation of arbitrariness (or even venality) of TA results frequently used in immunization strategies could be countered with refe- rence to suitable control procedures (publicity of the generation of TA knowledge enables both scientific and political-social review) (Frederichs/Blume 1990, p. 67) – an advantage that is at least much less given with decisionist concepts (Richter 1989, p. 166).

Such an understanding of TA as a program is of course itself subject to socio-political discourse and can only become practical to the extent that the rele- vant decision-making processes allow. At the same time, it contains implications for cognitive and institutional implementation, as can already be seen from the imperative and voluntary formulations.

4. Implications for TA as problem-oriented research

Implications for the cognitive implementation of "strategic" TA are obvious inso- far as the conceptual foundation is already on the problems and perceptions of industrialization and social technological development.

In terms of content, the reflexivity and self-reflexivity of TA must be directed toward the subject area to which it belongs (as an institutionalized process). At this point at the latest, namely with regard to the question of the appropriate conceptualization of technology development and technology "consequences," the aforementioned criticism of the "technology-deterministic" understanding of TA must now be taken up.

4.1 *"Impact" assessment as technological determinism?*

It cannot be a criterion of *problem*-oriented research per se whether and to what extent it analytically neglects certain aspects and dimensions of technology development. Selection is always necessary, but must be justified with regard to problem situations and not disciplinary claims. Thus, scientistic criticism of TA must also miss its object in cognitive terms.

Just as it likes to criticize the concept and practice by ignoring the problems and socio-political framework conditions, it usually attacks the concept of consequences without reflection.

Instead, a distinction should be made between the three most frequently used meanings of "consequences" in the TA discussion:

- At the *object level*, which is most easily accessible to scientistic criticism, the concept of consequences seems to imply causal or stochastic connections between "technology" and "non-technical" facts, although it would be better to speak of "effects" here, while the softer concept of consequences actually only implies a temporal succession of events (Böhret 1990, p. 35). In the criticized one-sidedness of technology assessment, the "autonomy of technology" is seemingly postulated – a "symbolic field" that only began to dominate social discourse in the 20th century (Gloede/Bücker-Gärtner 1989).
- At the *level of socio-political technology regulation,* the criticism of the concept of consequences amounts to a criticism of "reactive technology policy" (Ropohl 1985, 1989) and thus concerns the relationship between social subsystems (economy and politics) with regard to *the course of time and the influence* of technological development. Implicitly, in this context of meaning, considerable concessions are already made to the image of "autonomous" technology. In the same context, however, there is also a warning against overestimating the possibilities of political control, thus partially rehabilitating the "consequence orientation" (Knie 1989).
- Finally, at the *practical level*, the term "consequences" appears completely unsuspicious insofar as it is only a description of anticipatory social action.

Trivializing characterizations of TA that point to the "praxeological" ordinariness of impact assessments (Adam 1987) operate in this context of meaning. What is essential is that the anticipatable future consequences, effects, "consequences" of action are included in a consideration that precedes the act of action itself (Böhret 1990, p. 27f.; Roßnagel 1989a, p. 52).

Connections can be shown between these three contexts of meaning of "consequences" for the concept of TA. In the context of "reactive technology policy," the almost self-evident consequence orientation of policy in the practical sense must set different priorities and make different demands than in the case of active framework control or even finalized detailed control. The practical impact orientation gains a specific substantive concretization insofar as policy is not only confronted with the "consequences" of its own actions, but primarily with the "consequences" of others' actions. However, such a statement is linked to further-reaching assumptions. For which actor "reacts" to the "consequences" of which action can only be decided by choosing a certain temporal, spatial, and social frame of reference (Böhret 1990, p. 35). In the context of the socio-political regulation of technology, this statement therefore means "on balance" a dominance of other social subsystems over politics – a conclusion that is perhaps true overall (Briefs 1991; Stegmüller 1990), but by no means for all areas of technological development (Keck 1984).

Finally, it can be assumed that the dominant regulatory mode of "reactive technology policy" (Dierkes et al. 1988) has contributed to a not inconsiderable extent to the formation of the "symbolic field" of autonomous technology. The process of advancing technologization, which is difficult to explain in detail, accelerated by self-referential internal relationships of technical innovation, but above all hardly accessible for political control from "one point" due to decentralized social self-regulation (Hack 1988; Rammert 1990), supported the myth of a reified technology to which political action only had to adapt (Gloede/Bücker-Gärtner 1989). Only to the extent that this process threatens to jeopardize not only particular interests, but also the conditions of reproduction for society as a whole, does the question of recovery factors and control conditions find sufficient social resonance (Dierkes/Marz 1990, p. 13f.).

4.2 Consequences of a social science concept of technology

If, on the one hand, it must be noted that "impact orientation" in technology assessment is unobjectionable in a *practical sense* (albeit unfortunate due to the overlapping contexts of meaning) and is at least realistic *in terms of regulatory*

policy (which does not contradict limited attempts at intervention and design), then, on the other hand, we must take seriously the attempt to draw consequences from the more recent insights of technology research *at the subject level*[6]. Here we can tie in with the approaches of Joerges and Rammert, which in my understanding are complementary (Rammert 1990, p. 339). Joerges focuses more on the reification of action contexts in technical artefacts in terms of action theory and, by discussing such changing "connection conditions" of social action, points to the social implications of successfully used technologies (Joerges 1989) – a dimension that is definitely neglected in TA practice. Rammert's concept of "technicization" focuses on the social conditions and functions of innovation processes in a more system-theoretical context (Rammert 1989). Both concepts aim to integrate technology as a social category stringently into social science theoretical traditions, but for disciplinary reasons tend to neglect the reference point of a technologized appropriation *of nature* (and its sedimentation in the technical artefacts/processes) despite better intentions (similarly: Hennen 1991, p. 105ff.). Ultimately, this distortion can only be corrected through interdisciplinary cooperation (Landfried 1991, p. 101).

What are the consequences of this for directly problem-oriented TA? As a question about the sociological redemption of sociological desiderata, it ultimately appears unanswerable if one does not want to remain with the demand that TA practitioners should also rhetorically adhere to "largely shared objectives."

As problem-oriented research, TA *cannot* declare the development of technology theories to be its task in an independent manner – just as it is not capable of

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6   To clarify and at the same time correct a widespread misunderstanding, it should be noted once again that the "impact orientation" of TA is to be understood primarily in the aforementioned practical sense. This distinguishes it fundamentally from "impact research" or, more recently, "technology assessment research" (Gloede 1991), which is understood in interdisciplinary terms and primarily refers to the object level. Accordingly, a "memorandum on social science technology research" from 1984 already called for the addition of the perspective of "recovery research" (Memorandum Verbund Technikforschung 1984; cf. Dierkes/Marz 1990, p. 17). However, here as elsewhere, the object-related *perspective of research* is erroneously associated with the *modes of technology policy* (regulatory policy level).
The TA *concept* has never adopted the subject-related dichotomy of perspectives of disciplinary research, but has always focused on analyzing the conditions *and* consequences of technology use. Even in the context of regulatory policy, TA was never exclusively related to the anticipatory management of the consequences of already developed lines of technology, but always *also* to political decisions on the promotion of technologies – i.e., apparently to mechanization strategies in early phases of development (Rammert 1990, p. 345).

driving genetic research or the sociology of science. Work in these areas must ultimately justify itself by recourse to specific problems and perceptions of problems. Essentially, however, TA can and must actually observe its research environment, identify any need for further research in the context of its problems, and use the existing academic research findings for its project-based problem-solving.

This use can and must consist of a heuristic control of the conventional operationalization of problems. In this way, the hitherto mostly rhetorical postulate of also considering social "consequences" (including the dimension of psychological processing problems) could be taken seriously (e.g., Clemenz 1987). The transformation of the social consequences of mechanization into questions of acceptance should not be allowed to continue (Gloede/Bücker-Gärtner 1989, p. 236).

However, the fundamental consequence of an understanding of technological development as "technicization" is that innovation processes, entrepreneurial technicization projects, state funding and regulatory programs, and social and cultural adaptation efforts must always be understood as social "strategies" whose normative (e.g., "guiding principles") and factual implications must be taken into account (Wagnerdöbler 1989, p. 142ff.). As "strategies" they are by no means obvious. Social actors need not be aware of the strategies they implicitly pursue in the context of the mechanization of nature and self-appropriation (Böhme/Lutz 1987), nor are these strategies readily apparent to an observer. *Insofar as* the problems of TA studies relate, for example, to state funding or the regulation of technological innovation itself, an attempt must indeed be made to reconstruct the social implications of these technicization efforts without neglecting the nature-related implications. The most recent attempts of this kind can be seen in the TA studies on genetic engineering (van den Daele 1991).

At the *regulatory policy level*, too, a reified understanding of technology cognitively misses the problems that lead to the awarding of contracts. With regard to the problem perception of individual clients, a technology-fixated TA becomes blind to the political implications of interests if it forgets the strategic aspect of the mechanization in question. TA as research can only really fulfill its corrective function if it questions the *articulated* problem formulation from its perspective in the light of overarching considerations of the problem situation.

TA misses its function even more clearly if, for factual and social reasons, it has to examine technological developments in the context of *conflicting social interests and orientations* and is limited to an "objective" assessment of technologies in the sense of an assessment of "natural processes." The TA process should not only take these strategic implications into account at the end of the analysis (i.e., in the controversial assessment of the "consequences"), but from the very

beginning. It must therefore be examined whether a problem formulation capable of reaching consensus can be achieved at all through controversial negotiation processes (von Thienen 1989, p. 41f.). In case of doubt, parallel assessments are to be carried out here, the certainly controversial results of which are to be subjected to a mutual review. Either way, this constellation obviously describes the point of application of "participatory TA."

In my view, it would therefore be too little to call for "more" problem-induced TA, both in terms of the subject matter and in terms of regulatory policy (for technology impact research: BMFT 1989, p. 11). Rather, an understanding of "technology" as the result of social technicization strategies means that *only* problem-induced TAs should be carried out, i.e., even if individual technology lines or projects have been the reason for consideration in the sense of "technology-induced" TA studies. This is the only way to systematically open up the view for functionally equivalent problem-solving options (e.g., Gill 1991). In this way, the evaluation of the "consequences" of the technology lines under consideration, which is usually carried out in the light of alternatives and comparisons anyway, can be made accessible for explicit assessment. The *initial situation*, which is usually shifted to the consideration of "realization conditions" (e.g., Coenen et al. 1988), was then no longer neglected, but itself became an essential object of the assessment.

If a substantial problem orientation cannot be enforced with clients, it should at least be made clear which initial restrictions the study is subject to and what consequences this has for its results. In cases of doubt, it should even be considered whether it makes sense to accept the commission at all under the given circumstances. In some cases, *all* parties involved may be better served by rejecting it than by tolerating problem-adequate specifications.

The last consideration already addresses the consequences for institutional program implementation.

5. Institutional conditions

TA as a mediator between problems, their political treatment, and scientific research has "implementation problems" – in both directions, as we have seen. As wrong as it would be to try to resolve the dilemmas reflected in the concept of TA by *adapting* it to external socio-political conditions, it would also be inadequate to simply *withdraw* to academic research and only seek a contemplative relationship to social problems (von Thienen 1989, p. 44f.).

If, under these conditions, it must be part of TA's programmatic self-image to generate a specific form of strategically oriented knowledge and to see itself as a participant in strategic "games," then such a program is only promising under suitable institutional conditions.

Because TA is necessarily part of a more or less broad technology policy discourse or manifest conflicts in society, it is sometimes demanded that this discourse as a whole be seen as a "TA process" (Kollert 1984; cf. also Lohmeyer 1984). It seems to me, however, that the work of the Öko-Institut or the IFEU is also clearly different from the immediate "raging of the technology policy opinion war." Even though it is part of this social decision-making process, problem-oriented TA research nevertheless requires a relative distance from politics, disciplinary science, and the public.

Relative *distance from politics*, while at the same time demanding proximity, cannot be guaranteed by relying on science alone. Accordingly, institutional (financial and legal) independence must be ensured in such a way that political guidelines cannot have an unfiltered impact on research. Sufficiently high basic funding in conjunction with discursive management and supervisory structures are necessary but not necessarily sufficient prerequisites in view of practical experience. As a supportive flanking measure, circumstances should be sought which grant pluralistic social forces approximately equal influence on the processes of problem formulation for TA (van den Daele 1991, p. 40f.; Naschold 1987, p. 21ff.).

Relative *distance from disciplinary science* and simultaneous proximity appears to be less of a problem under the given circumstances. At first glance, the establishment of relative proximity to disciplinary research is much more urgent. Insofar as TA has to keep in touch with disciplinary concepts and procedures and seeks to implement them in a problem-oriented and problem-adequate manner, it must necessarily face disciplinary discourses for the examination and control of its results.

As the discussion of the scientivist critique of TA shows, it would nevertheless be misleading to disciplinary programs from the point of view of problem orientation. In this context, TA should not see itself as a "dirty" derivative of "pure" research, but should strive for an independent specific achievement with regard to problem orientation as well as – important in this context – multidisciplinary problem *solving* (van den Daele et al. 1979, p. 57). Crossing disciplinary boundaries and transferring conceptualizations (from one discipline to another) has sometimes proved to be extremely fruitful for disciplinary developments. At the same time, from such a perspective, specific disciplinary blindnesses and

conditions of validity (e.g., of impact research) come into sharp focus (Becker 1989).

Relative *distance from the public* and simultaneous proximity as a requirement of TA practice should certainly be reversed at present. Participatory TA hardly takes place under the current conditions, and active participation in public discourse also leaves much to be desired.

On the other hand, it is obvious that TA cannot be absorbed into public discourse. Without relative distance, TA cannot perform a corrective function vis-à-vis the public. Here, both against conservative arguments (Adam 1987) and against "green" expectations (Gill 1991, p. 19f.), the qualitative difference between political and scientific technology *assessment* must be pointed out (van den Daele 1991, p. 44ff.).

The relative distance of TA from its environment outlined in this way (Beck 1986, p. 280) ultimately raises the question of what legitimacy the "strategic" participation in technopolitical interactions and communications called for above can have.

From more academic experiences with political consulting, Daxner postulated that a "new" science, taking into account its functions in the industrialization process, could not avoid

> [...] opening up and conquering a position of power whose goal would have to be the generation of problems rather than the solution praxeology. [...] The new science had to start where it was a matter of *enforcing methods that were already largely known* (Daxner 1988, p. 55).

Such a postulate can only *be legitimized* against the background of objective problem situations and socially shared problem perceptions that include the functionality of TA (as a "new science") (Daxner 1988, ibid.). *The necessity* is derived from the fact that most of the modern problems of the "risk society" can only be understood incompletely or not at all without the contribution of the sciences (Beck 1986, p. 254ff.). However, *the possibility* for TA to conquer "positions of power" does not result from its own strength and will. It is crucially dependent on situational circumstances and strategically reflected coalitions (Bronfman 1991, p. 77; Nowotny 1980, p. 173ff.; Rip 1987, p. 168ff.).

However, Daxner's political plea also runs the risk of blurring the difference between politics and science. The results and opinions of TA must be aware of their "relative" validity, which goes back to their specific social *practice* as problem-oriented *research* (Beck 1986, p. 290; Wingens/Fuchs 1989, p. 217). They cannot dispense with overarching political decision-making processes and must

reckon with their virtual "functionality" even if this does not appear plausible in a science-centered understanding of rationality.

The basis of "power-political" action of TA can therefore only consist in its *specific* contribution to the identification and processing of problem situations – this is where strategic TA finds its limits, but also its justification (similarly: Lau 1989, p. 415).

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