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Concept development of technology assessment: Review and outlook

1. The social background: From enthusiasm for technology to technology ambivalence

As in all highly industrialized countries, there was a relatively broad and firmly anchored consensus in the Federal Republic of Germany until the end of the 1960s in the assessment of scientific and technological progress. A clearly positive attitude toward technical and scientific developments prevailed among large sections of the population, as they were seen as a reliable guarantee for economic growth as well as personal and social welfare (Andersen 1997). The state was expected to create the conditions for closing the existing or expected technological gap with other industrialized nations – above all the United States – as quickly as possible through a proactive research and technology policy. A socially relevant technology acceptance problem did not exist (Dierkes/von Thienen 1977, p. 2; Dierkes 1984, 1989a, p. 67ff., p. 69ff.).

This situation changed fundamentally from the late 1960s to the early 1970s, and the enthusiasm for technology that had prevailed increasingly gave way to a distanced and critical attitude. There were two main reasons for this:

- Firstly, more and more people were confronted with indirect, unintended, and long-term secondary and tertiary effects of new technologies, both at the micro level of their working environment and at the macro level of their living environment. Scientific and technological progress and the welfare of society as a whole therefore no longer automatically went hand-in-hand but, in the opinion of a growing proportion of the population, conflicted at more and more points.
- Secondly, traditional and new social movements focused on people's concerns and worries and intensified them through broad media coverage. Acceptance of technology could no longer simply be taken for granted, but became a socially relevant problem (Dierkes/von Thienen 1977, p. 3ff.; Dierkes 1984, 1989a, p. 69ff., 1989b, p. 67ff.).

At first glance, it seemed that fear or even hostility toward technology was spreading. However, a series of surveys quickly showed that neither technology nor scientific and technological progress per se was fundamentally questioned. The negative attitude was not primarily related to the technology itself, but rather to the neither intended nor foreseen social, political, economic, ecological, and cultural consequences resulting from its use. Although these concrete, unintended consequences became the starting and crystallization points for controversial discussions and/or differentiated forms of protest, the increasing unease was rooted more deeply than just in one or another spectacular individual cases (Dierkes 1985, 1986a, p. 24, 1989b, p. 68). Rather, the assumption that scientific and technological progress and social progress were in a linear, directly proportional relationship to each other, which had guided actions and decisions for a long time, was fundamentally shaken.

While the problem of technology acceptance superficially appeared to be a loss of trust in scientific and technological progress, a closer look at the phenomenon clearly showed that at its core this was more about a loss of trust in the social mechanism whose task it was to promote and control this progress and steer it in the socially desired direction. The increasingly obvious differences between technical goals and social and ecological outcomes were not simply attributed to technology in the technology acceptance discourse, but were instead seen as part of the dysfunctionality of this mechanism.

The institutions found themselves in a crisis, which became particularly evident in two symptoms: A lack of awareness of the problem, and a growing displacement of the problem. Firstly, the growing distrust of many citizens toward the increasingly serious risks of technological progress was only gradually recognized by the majority of state institutions and companies. Secondly, there was a growing tendency to shift decision-making processes for the concrete use and application of new technologies from the legislative, executive, and administrative levels to the judiciary, where they inevitably accumulated, as they could be resolved neither competently nor quickly due to their complexity and intricacy (Dierkes 1974a, p. 24; Dierkes/von Thienen 1977, p. 3ff.; Lohmar 1977). From the very beginning, technology acceptance was therefore not only a problem in the social sphere, but above all a problem of the social sphere. Against this background, the question inevitably arose as to how social science technology research could provide the basic knowledge required to deal with the acceptance crisis.

The social science debate on the social problems of technological change, conceptualized as questions about technology, reached an initial peak in the early to mid-1980s in German-speaking countries.

2. Societal technology control as compensation for inadequate self-control

However, the ensuing efforts to develop comprehensive and coherent concepts for technology control also raise the question of why steering and corrective interventions in technical development are necessary at all, and why progress is not simply left to a market or a political selection process. On closer inspection, however, the difficulties of such a selection mechanism quickly become clear. Since there are no markets in the traditional sense for many of the new technologies that are subsidized by the state or predominantly used in the public sector, there are no feedback mechanisms that can adequately control technological progress with regard to society's quality of life. However, it is precisely the most diverse quality-of-life-reducing effects of technologization that are generally the starting point for the demand for society-related control of technology. Feedback through the mechanism of political elections works imperfectly with regard to state-funded research and development (R&D), as technology policy issues only play a subordinate role in electoral decisions. However, a change is to be expected here, as a further increase in political pressure can be expected under the impression of the diverse negative environmental effects and under the influence of citizens' initiatives, and environmental and consumer protection groups, especially if these groups succeed in joining forces across national borders within the framework of Europeanization.

In addition, the development of new technologies, even when it took place with state support, was for a long time – and to a large extent still is today – essentially oriented toward the criterion of private sector profitability and the market mechanism as an assessment process (Dierkes/Bauer 1973; Dierkes 1974b). Apart from a few exceptions, macroeconomic aspects were and are hardly taken into account. Insofar as side effects of new products or processes were included in the decision-making considerations – mostly due to legal regulations – this was largely limited to selective, direct, and predominantly technical aspects. With regard to society's objectives, however, microeconomic profitability is too limited a criterion for such decisions. Furthermore, the participants in the market process, primarily the consumers, are not, or only to a modest extent, in a position to function efficiently in the role of "assessor" of a new technology, as they generally lack any systematic information, especially about the side effects already mentioned (National Academy of Science 1969; Geschka/Schwerdtner 1974), and often the buyers are not those who suffer the burdens of the side effects.

In addition, due to the long duration of innovation processes, market success as a decision criterion for the overall economic desirability of specific technical progress only provides the corresponding "feedback" at a very late stage. Extensive productive resources may then have to be regarded as misdirected, or the technical development is ultimately "brought to market" under the pressure of the R&D expenditure already made with the help of marketing instruments.

As the traditional decision-making criteria and calculations are therefore significantly flawed, both with regard to decisions made by the private sector and by the state regarding the type, scope, and direction of technological progress, it is advisable to look for an efficient way to compensate for this. Technology assessment is probably the first planned and goal-oriented approach that should provide a remedy here.

Technology assessment – the traditional way to overcome the acceptance crisis

Initially, social science technology research focused on the development of an "early warning system for technology impacts." Under terms such as "technology assessment" (TA), "technology evaluation," or "technology impact evaluation," international research efforts since the late 1960s have increasingly sought to develop concepts aimed at analyzing and evaluating the conditions and potential effects of the introduction and widespread application and use of technologies as systematically as possible, with the main aim of analysis being to investigate the indirect, unintended, cumulative, and synergetic secondary and tertiary effects of the introduction and application of new technologies on the environment and society (Dierkes/Staehle 1973; Dierkes/von Thienen 1977, p. 3; Dierkes 1984, 1989a, p. 69ff.). In general, technology assessment is defined as an integrated and systematic assessment and prediction of the significant (positive and negative, direct and indirect) effects in the central areas of a society (economy, environment, institutions, general public, special groups) that occur when a technology is introduced or changed. The concept includes the requirement that the effects of technologies already in use should also be reviewed from time to time, particularly in the case of changing requirements and changes in scale. The task of a technology assessment study is therefore to use scientific analysis to identify side effects, "spill-overs," and other direct and indirect advantages and disadvantages of using a technology (Coates 1972, p. 1ff.; Dierkes/Staehle 1973, p. 5; Knezo 1972).

From the outset, TA research was conceived as a policy-related information tool that was intended to directly serve practical knowledge and action interests. Concrete proposals were developed from the research experience as to how the institutional crisis that had become apparent in the "acceptance crisis" could be overcome in the short-, medium-, and long-term. Based on the models of the "Royal Commission," the "Researchers' Parliament," and the "Science Court," differentiated variants for the reorganization of research and technology policy institutions and their effective interaction were developed (Dierkes/von Thienen 1977). This direct practical orientation necessarily led to terminological and conceptual blurring, as the definitional boundaries for studies that should be attributed to technology assessment were interpreted relatively broadly (Paschen 1986, p. 23). Furthermore, TA research was multidisciplinary from the outset, since a differentiated and systematic assessment of the possible consequences of the introduction and application of a technology would have to take into account and examine a wide variety of impact fields. This could only be achieved by integrating methods and procedures from the natural, technical, and social sciences (Dierkes 1984).

In order to counter the methodological and conceptual difficulties faced by TA research designed in this way, four approaches were adopted:

- Firstly, general flowcharts and checklists for the methodological and practical approach to studies were developed to outline the TA approach. Framework concepts of this kind, such as the flow chart drawn up by the MITRE Corporation[1] (MITRE 1973) or the Organisation for Economic Co-operation and Development's (OECD) catalog of requirements (OECD 1975), required a more precise definition in each individual case, depending on the specific research question; nevertheless, such concepts can provide helpful methodological advice for specific studies (Dierkes 1989b, p. 74).
- Secondly, TA research has pointed out that technology assessment should not simply be misunderstood as a one-off and then completed investigation process, but rather as an iterative analysis cycle in the sense of a "process-based technology assessment."
- Thirdly, concepts were developed in the direction of complementary partial analyses, in which partial studies are carried out on selected areas that are in particular need of analysis and then integrated into an overall picture (Dierkes 1981, p. 340ff.).

1 *Editors' note*: For further information, see: https://www.mitre.org/ (accessed 09.04.2025).

- Fourthly, historical analyses were to be used to reconstruct discourses on technology assessment in the past; this approach was obvious, as problems with undesirable adverse consequences of technology are as old as technology itself (van der Pot 1980). In this way, not only surprising and unexpected insights into historical processes could be brought to light, but above all research results of great topical relevance. (Dierkes 1986b, p. 145ff.; Dierkes et al. 1988).

Despite these and many other efforts, fundamental criticism of the usefulness of technology assessment has been voiced time and again. In addition to criticizing the methodological and conceptual weaknesses of TA research, the general usefulness of TA research has been questioned with reference to the impossibility of accurately forecasting the future. However, regardless of where the criticism comes from and where it is directed, it can always be countered by the fact that there is basically no choice for or against technology assessment; there is merely a field of alternative and complementary paths along which it can develop and qualify (Dierkes 1984). Particularly problematic are the usually completely inflated social expectations of TA research, with politicians in particular hoping for a quick and smooth elimination of acceptance problems. The hopelessness of this is based on the fact that TA research can provide information on new technologies and the negative and positive secondary and tertiary effects to be expected from various alternatives. However, it is not in a position to replace the debate about the opportunities and risks of technologies by providing an "objective" political decision.

In order to systematically minimize the existing differences between the knowledge needs of the public and politics on the one hand and the knowledge offered by TA research on the other, communication processes between science, the public, and politics must be developed, purposefully unfolded, and institutionally anchored. The proposals made by various organizations such as the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), the Association of German Engineers (VDI), and various social science research institutions in the first half of the 1980s were aimed in precisely this direction (Dierkes 1984).

The limits of traditional TA research

Even if the possibilities of traditional TA research have not yet been exhausted, there are also limits to this approach that leave room for alternative models. Technology control that is primarily aimed at the consequences of technology often resorts to regulations such as requirements, laws, rules, and technical standards, i.e., a form of technology regulation that can be traced back to the second half of the 19th century (Dierkes 1990b). A look at the history of technology assessment illustrates the problems with which this approach has repeatedly been confronted. Three stages of development can be identified, which can be roughly outlined as follows (Dierkes 1990a):

- The first stage: In an effort to regulate the consequences of technology, the role of the state, scientific associations, and entrepreneurs was defined very early on. The Prussian Industrial Code of 1845, for example, operationalized a large number of instructions and procedures. This type of impact regulation was characterized above all by its reactivity, i.e., techniques were first introduced and then, when unintended and undesirable side effects occurred, processes were set in motion to eliminate or at least reduce them. As a rule, these processes were partial regulations in which specific effects of a technology were subject to conditions, regulations, and occasionally also laws. However, scientific and technological progress often created new problems with the same technology, so that the process of permanent partial regulation often lagged behind and was usually only marginally effective. The shortcomings in the enforcement of many laws, which are well known today, had a particularly problematic effect, dragging the state into the ups and downs of regulating the consequences even back then.
- The second stage: A change was initiated in the second half of the last [19th] century when a more restrictive understanding of the state's role in regulating technology was developed and professional institutions were increasingly relied upon to control technology. This led to the emergence of a different state regulatory mechanism, particularly after the technical deputation for industry was established and implemented. Specific regulatory tasks began to be delegated to professional institutions, which then took on the detailed regulation in what was then known as scientific-technical collaboration, while the state essentially concentrated on defining the broad framework conditions. This regulatory mechanism is more differentiated, but remains essentially reactive: A problem arises, is recognized as requiring regulation, and is fed into the regulatory mechanism until it is eliminated. However, this strategy is still unavoidable today, because despite all efforts in the field of technology assessment, it will never be possible to fully and completely anticipate the entire spectrum of all consequences.
- The third stage: In the 1970s and 1980s, a scope for decision-making was discovered, particularly in the context of efforts to humanize work, which had not previously been perceived, at least not to this extent. The studies

of a whole series of social science institutes largely agreed that many of the consequences of technology, particularly with regard to the effects on working people and the working environment, are ultimately rooted in the specific organizational framework created for the use of technology. The most popular example is probably the well-known studies on the use of CNC machines. In many cases, technology impact problems that arise in practice are solved using corporatist negotiation models.

Even if this sketch is only very rough, it still points to the question of whether the traditional mechanism of technology control does not have weaknesses that can be, if not remedied, then perhaps reduced by complementary approaches to technology control.

3. Technology genesis as an opportunity to supplement traditional TA research

One approach that has been aiming to expand traditional control mechanisms for some years now, and which is also mentioned in a memorandum on social science technology research in the Federal Republic of Germany published in 1984 (Dierkes et al. 1984, p. 10), is technology genesis research. The phase of technological genesis, i.e., the stage of technical development that extends from the definition of the problem to the first usable industrial product, and in which the pathways are defined that act as a kind of "invisible selection filter" for further developments, is to be identified, described, and comparatively researched. In particular, the interactions between technical and social change should be given greater consideration in social science technology research (Dierkes 1988, p. 50, 1989a, p. 3ff.; Knie 1989b, p. 378).

The genesis of technology: research beyond social and technological determinism

When approaching the field of technology genesis, i.e., the area in which decisions are made about R&D, in which technical lines of development are promoted, stopped, redirected, or abandoned, according to criteria that are intrinsic to the respective institution that makes the decisions, then one is almost inevitably confronted with a classic alternative question: Is there a technological determinism or a social determinism? Or, to put it less sharply: Which of these two determinisms prevails? Two quotes illustrate the rather contradictory positions taken on this topic. At a colloquium in Berlin, Professor Spur expressed the following view:

> It should not be overlooked that technology is an economic and political factor with its own laws, which has considerable social significance, but which, on the other hand, has its own dynamics that can hardly be controlled on a global scale (Spur 1989, p. 5).

This is in extreme contrast to the view expressed by Habermas in 1963: "Judged by their structure, we see no functionally equivalent alternative anywhere for the non-institutionalized progress of science and technology. The innocence of technology, which we must defend against its suspicious despisers, consists quite simply in the fact that the reproduction of the human species is bound to the conditions of instrumental, even purposive-rational action, and that therefore not the structure, but only the scope of the technical power of disposal can change historically." (Habermas 1986, p. 348)

There is a great danger of getting lost in this maze of alternative questions and being trapped in practical terms. If, for example, technological determinism were actually at work, especially in such a way that scientific and technological progress is driven forward by an almost uncontrollable momentum of its own, then all efforts to influence it would a priori be pointless and without consequences. There would only be a choice between technological fatalism and abandoning technology. On the other hand, technology-deterministic tendencies can hardly be dismissed as purely intellectual constructs. It is obvious that what is available in terms of technical knowledge very much determines what is considered feasible and sensible in the future. And major infrastructural investments, for example, very effectively define technical development paths. If a society has invested so much in its highway and road network, then technical progress in the field of transportation will be pushed in the direction of developing modifications and improvements to the automobile or similar vehicles for a very long time. As a rule, technical alternatives that require a completely different infrastructure will inevitably find it extremely difficult to establish themselves. A model of the technological-genetic field should therefore be located beyond the extremes of pure technological or social determinism, as this is the only way to avoid the danger of one-dimensional and one-sided explanations of technological progress.

Outline and structure of the techno-genetic research approach

In summary, technology genetics research is based on the assumption that the selection and elimination decisions in the process of developing technology are shaped by the organization-specific interpretation of general technical models. The implementation of these guiding principles in organizationally characteristic research strategies takes place using organization-specific construction styles and is based on the selection and application of existing scientific and technical knowledge determined by construction and research traditions. There are therefore four main factors that influence decisions in the field of technology genesis, namely construction and research traditions, construction and research styles, organizational and corporate cultures, and guiding principles.

- *Traditions of construction and research*: These function as a kind of historically-oriented perception filter to which all existing knowledge that is somehow relevant for a new development is subject. Not all existing knowledge is equally present in R&D decision-making processes at all times. Shaped by the filter of their respective R&D traditions, certain groups of engineers or certain teams of scientists see the various segments of existing knowledge as having different relevance in relation to the innovations they are striving for. These traditions serve them – consciously or unconsciously – as selection criteria for determining which knowledge segments of the entire knowledge pool are relevant and which are not (Dierkes 1988, p. 55; Knie 1989a, p. 45ff.). At the time when Rudolf Diesel developed his engine, for example, many engineers were actually striving to develop decentralized power generation systems because the previously dominant paradigm of centralized power generation – i.e., the large steam engine with the corresponding peripherals – was increasingly reaching its efficiency limits. And all of those working on this problem drew on existing knowledge – only they did so in different ways. Diesel saw the problem through a different lens than the traditional engine builders because he came from the refrigeration industry, where he was used to working with materials that could withstand high pressures. The traditional steam engine engineers, on the other hand, started from the experience that there was a certain limit to the level of pressure that could not, in principle, be exceeded for material reasons. Diesel basically did nothing other than perceive the existing knowledge differently, select it, and then recombine it. He illuminated it with a different spotlight, so to speak, and thus developed a new engine concept. Bound up in the design tradition of the steam engine, engineers at the time were unable to make use of this concept because their specific patterns of perception of the aspects of existing knowledge to be regarded as relevant systematically excluded precisely those elements from their search grid that Diesel considered relevant based on his completely different experiences.
- *Construction and research styles*: Construction and research traditions do not determine the patterns of thought, behavior, and decision-making in the development process in a straightforward manner. Whether and to what

extent these traditions are stabilized, reinforced, broken, or recombined in the organizational contexts of companies and research institutions depends on which generalized ideas about appropriate problem-solving procedures and which concrete type of approach to R&D tasks – from the selection of the instruments used to the measurement procedures to the evaluation criteria – dominate in these organizational contexts. The term "research and construction style" aims to capture the cognitive, methodological, and material form of technical problem-solving specified in the organizations (Dierkes 1988, p. 55; Knie 1989a, p. 47ff.). The importance of such styles is particularly evident in the open decision-making situations characterized by great uncertainty that are typical of R&D processes. When, in the last third of the 19th century, the demand for decentralized energy in many areas of the economy increased by leaps and bounds, but steam engine technology came under increasing criticism due to its high acquisition costs, costly maintenance, the nuisance caused by smoke emissions, and the constant danger of boiler explosions, companies in the German engine manufacturing industry stuck to the established energy technology development line. Although hot-air and gas engines were already being developed as alternatives, the prevailing design and research style in the companies concentrated on adapting this established line to the changed requirement profiles within the framework of the limited technical possibilities.

- *Corporate and organizational culture*: At the latest since the shift in R&D processes from the individual level of the more or less isolated single inventor to R&D teams in organizations, the weight of organization-specific factors has increased considerably (Dierkes 1988, 1989b, 1990c; Dierkes/Berthoin-Antal 1985; Dierkes/Knie 1989). Technology genesis decisions are usually those that are made under great uncertainty of outcome. However, the greater this uncertainty is – whether due to the long-term nature of the input-output relationships or to their non-linearity – the more they are determined by the fundamental perceptions, values, basic assumptions about strategies, and behavioral concepts that dominate in the organization in which these decisions are made. The aim of the organizational culture approach is to capture the ensemble of coupling factors between the external and internal worlds of organizations (Dierkes 1987, p. 163f.). This approach thus focuses on two analytical perspectives. On the one hand, the aim is to capture the totality of these factors and their interplay, their synthesis; on the other hand, the organizational culture approach aims to do this not in an abstract system-theoretical way, but in an object-specific way, by trying to capture the

particularity and uniqueness of this ensemble and not to abstract it away.
Organizational culture can be briefly defined as "collective programming of the mind" (Hofstede 1980, p. 30). It is a pattern of basic assumptions developed by a particular group of people who have worked together long enough to have shared significant experiences in their efforts to solve the problems of adaptation to their external environment and internal integration. Such basic assumptions are internalized by the members of the organization through their everyday cooperative relationships and often act as tacitly assumed background knowledge on organizational decision-making behavior. Anyone who has changed institutions in their professional life or who has worked in different institutions at the same time has certainly experienced that there are often subtle but nonetheless effective differences. It is equally obvious that companies perceive the same environment in different ways depending on the organization. The automotive market of the future, for example, will look different from the perspective of different manufacturers, even if they use the same or similar data as a basis.

- *Guiding principles*: Wherever people discuss, argue, and decide with each other about scientific and technological progress, its direction, and its content, certain technical guiding principles are encountered. These guiding principles bundle the intuition and knowledge of individuals as well as the collective consciousness of the institution about what is feasible on the one hand and desirable on the other (Dierkes 1988, p. 54, 1990b). Thus, technical models are clearly different from science fiction – although they may have some relation to it – because they are defined by two boundaries. On the one hand, they operate at the limit of what is still technically conceivable, possible, and, above all, feasible, and on the other, at the limit of where people have or could develop a need or desire for it, i.e., where potential markets, needs, or users exist for a technology that is regarded as conceivable and feasible. Such technical concepts are well known. The "paperless office," the "unmanned factory," and "artificial intelligence" are just a few examples. An image that is no longer fondly remembered, namely that of the "car-friendly city," shows the material power that such technical models can assume. Entire generations of architects and urban planners were trained under this model, and thought and acted according to its calculations.
In discussions about the specific direction in which certain technologies should develop, technical models act as fixed points and points of reference. Of course, guiding principles are also inevitably subject to changes and cycles. There are international fashions under which guiding principles change,

and there are obviously countries that are more influential than others in international competition. If certain countries are fixated on certain technical models in certain fields of technology, this often has a kind of suggestive pull effect. Technical models are often also supported and disseminated by professional associations in individual fields of technology or sectors of industry, but also by subgroups of these.

With this brief outline of the technology genesis approach, which is based on the four central concepts, a general hypothesis framework has been developed that needs to be tested, modified, and, if necessary, falsified in specific empirical studies. Despite all the skepticism that has been expressed toward this approach, which is based on the rather "soft" factors of technology development, it seems to be worth examining whether it has the potential to complement TA research as a traditional form of technology management. One focus for the future should be on empirical studies on the genesis of technology in particular, as only being measured against reality can provide information on the ability of technology genesis research to assist in society-oriented technology management.

4. Next steps in technology control: Regulating consequences and controlling causes

Experience to date has shown that the concept of technology assessment, particularly with its focus on a broader set of objectives than previous cost-benefit studies, including side effects of a more distant nature, can make a significant contribution to improving the decision-making basis for the application of new technologies. This is likely to be a first important step toward steering technical progress not solely on the basis of private-sector criteria, but with a stronger focus on society. Despite the success of traditional TA research, it seems at least worthwhile to also pay attention to technology genesis research and its potential for efficient technology management. However, we must urgently warn against seeing a new doctrine of salvation in the genesis of technology, as we can expect nothing more than a complementary model to the forms of control practiced to date. A look at their respective core orientations shows how fruitfully these two approaches can complement each other. While the TA approach as a "hard" form of control focuses on the paths of technical progress and their direction in order to prevent technical development and its secondary and tertiary effects from escalating and becoming unbalanced, the technology genesis approach with its "soft" technology control aims to put different development paths up for discussion and thus also for negotiation. TA research and the technology genesis approach can – provided that these two approaches interact harmoniously – be taken as an example of the interaction between different models for technology management, which also leave room for other ideas and concepts for technology management. Traditional TA research would then form the common starting point for different strands of research, which could perhaps one day be united as the building blocks of a social science theory of technology development to form a coherent theoretical structure. Efforts in this area could be particularly worthwhile at present, as the field of technology seems to have become quieter in the social sciences in the 1990s. This is a good opportunity to take time out from the hectic day-to-day business to consider the question of how technology can be shaped and the consolidation of different research approaches.

However, it should be emphasized once again that it will never be possible to fully anticipate new knowledge or completely predict all possible effects of new lines of technical development. No approach to technology control and no closed theory will ever be able to do this. TA research can provide information on the possible and probable effects of new technologies; it can provide decision support in order to select the alternative with the least negative or highest positive secondary or tertiary effects from several available alternatives. It can also suggest measures to reduce, correct, or compensate for unintended negative consequences of the use of new technologies (Dierkes 1989b, p. 76). In short, it can create a basis for the normative evaluation of technology in terms of acceptability and provide basic knowledge for a public discourse centered on this, thereby substantiating and qualifying this discourse, but it cannot replace this discourse.

It is therefore important for the use of TA information in politics, science, industry, associations, and organizations as well as the general public that institutional arrangements are also created to bundle the scattered knowledge from different technology assessment processes in such a way that it is available quickly and in a targeted manner when required. This process has three main objectives:

- Integration of the individual results obtained into generalized bodies of knowledge about the relationships between technical development and social, ecological, and political systems;
- Communicating this condensed TA knowledge, which is integrated into overarching contexts, to decision-makers in politics, business, associations, and the general public interested in these issues, and
- Collection and bundling of methodological and organizational experience in the implementation of TA processes.

The importance of this task, which should not be underestimated, is related to the fact that only the integration of as much of the available knowledge as possible can ensure that political decision-makers are provided with well-founded and substantial findings on new technologies that enable a qualified discursive debate and thus a responsible decision about new techniques in the first place (Ullrich 1997, p. 105).

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