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Rational technology assessment[1]

The development of modern science and technology since the 16th century has by no means always been received with unreflected euphoria and without critical commentary. Apart from rather selective antipathies toward individual technical innovations, e.g., the introduction of the railroad, entire epochs such as Romanticism were fundamentally skeptical about the assumption of progress with regard to modern science and technology. In the 19th century, the social consequences of the technical process, for example for the health and welfare of workers, and the underlying questions of distributive justice within society, were the main focus of the debate on technology and science. However, these experiences and reflections did not lead to a *fundamental* problematization of science and technology. Rather, it was about the question of ownership of these "means of production" and their social embedding. Between the major political-social antagonistic system concepts of the 19th and 20th centuries, the role of science and technology in guaranteeing progress was therefore not fundamentally controversial. Rather, fundamental criticism of science and skepticism of technology were regarded as characteristics of pre-modern attitudes to life and reactionary political concepts. The solution to the consequential problems of scientific and technological developments was seen on the one hand in political or economic control measures, such as the establishment of the welfare state, and on the other hand in revolutionary ideas about fundamental social upheavals. A social discussion about the fundamental justification conditions for scientific and technological action has therefore only been possible since the grand concepts of socialism and capitalism began to lose their power to provide orientation, for various reasons.

The desideratum of a critical reflection on the development of science and technology in recent decades is closely linked to events that have rendered the basic optimistic attitude toward progress and new scientific and technological developments implausible. Disgust at the military implementation of scientific

1 *Editors' note*: This article is the introductory chapter to "Rationale Technikfolgenbeurteilung" (Grunwald 1999). As it contains references to other chapters included in the present book, the article has been adapted and shortened accordingly for our purposes.

discoveries (e.g., as part of the Manhattan Project[2]), unease about the increasing speed of mechanization, fears about the limits of growth, and growing sensitivity to technology-related risks to the environment and society have led to an increasing "demystification of technological progress" since the 1950s. Since then, the justification of science and technology has been called into question by considerable groups in the public debate. In this debate, the sciences play a complex and ambiguous role both as problem-*causing* (e.g., as producers of chlorofluorocarbons; CFCs) and problem-*discovering* (e.g., as empirically determining the depletion of the ozone layer) and problem-*solving* bodies (e.g., in the provision of substitutes). Since the 1970s, this ambiguity has given rise to an increasing need for critical reflection to advise politicians and society on controversial issues relating to the development of science and technology, to shape science and technology policy, and to avoid negative consequences for society and the natural environment. This advice, for its part, should meet the standards of scientific rationality.

1. Technology assessment and ethics of technical action

The scientific approach to the consequential problems of scientific and technological developments can be traced in two main lines of discussion: Technology assessment (a), which is more influenced by the social sciences, and the ethics of technical action (b), which is anchored primarily in professional philosophy.

(a) Initiated by the American discussion on "technology assessment" (TA), a large number of advisory institutions have been founded in the last 25 years, through which science and technology policy decisions are to be placed on as broad a basis as possible in order to be able to take account of the aforementioned objectives in the complexity of these decisions (Westphalen 1997). Scientific advisory capacities in science and technology issues are essentially designed as internal administrative bodies to advise the executive, as parliamentary institutions, independent scientific institutes, or according to a network model of these institutionalizations. These are often relatively small institutions that primarily provide methodological expertise and work together with research institutions and experts from the relevant specialist areas on specific topics. In this way, TA

2 *Editors' note*: The Manhattan Project was a U.S. research and development program during World War II to produce the first nuclear weapons. It was carried out in collaboration with the United Kingdom and Canada (see also Bechmann & Frederichs in this book).

has become an institutionalized and interdisciplinary cross-sectional task of the science system, which in many cases, however, is integrated into the political institutional structure and whose "scientific nature" has therefore been repeatedly problematized.

Examples include the following institutions:

- Parliamentary TA institutions: Office of Technology Assessment (OTA) at the U.S. Congress (founded in 1972, dissolved in 1995), Danish Board of Technology, Netherlands Organization for Technology Assessment (NOTA, Rathenau Institute), and the Office of Technology Assessment at the German Bundestag (TAB);
- TA networks: European Technology Assessment Network (ETAN), European Parliamentary Technology Assessment (EPTA), and International Association for Technology Assessment and Forecasting Institutions (IATAFI) as examples of loose associations of individuals or institutions.

Such institutions attempt to implement various methodological and strategic concepts (Gethmann/Grunwald 1996). What they have in common is an approach that is more in line with the original concept of the OTA, which can be described with a certain degree of coarseness as "descriptive". The focus is on reports prepared for the purposes of decision-makers on the state of knowledge and skills with regard to the probable consequences. The most important task, in addition to identifying options for action, is to assess the existing use of technology, its consequences, and possible socio-political repercussions. Normative judgments about the scientific and technological options are either excluded or at least undesirable by the commissioning of the research, and are at any rate not part of the institutions' self-image. The distinction between technology impact research and technology assessment (cf. Ropohl 1996; VDI 1991) reflects this descriptivist self-determination. Behind this is the view (supported in the philosophy of science, particularly by Max Weber and critical rationalism) that normative statements cannot be justified in a generally binding manner and are therefore a fortiori not scientifically valid. Instead, "evaluations" are relegated to a sphere that is often described in an unclear sense with the word "politics". This reticence toward "evaluations" documents the "positivist hesitancy" of TA (Petermann 1991, p. 285) as the result of a decisionist division of labor: According to this, science provides ("value-neutral"!) facts, and politics then makes the value-laden decisions (cf. on this criticism also Nida-Rümelin 1996a, p. 808f.).

(b) Philosophical ethics has a long tradition of dealing with questions of science and technology (Mittelstraß 1992; Gethmann 1996a/b; Nida-Rümelin

1996b). This is probably one of the reasons why the representatives of philosophical ethics who deal with applied questions of science and technology have only recently addressed TA in the sense of (a) (Mittelstraß; Gethmann). Discussions about a professional ethos for engineers and about the responsibility of scientists in the wake of the atomic bombing of Hiroshima and Nagasaki are examples of philosophical reflection in the sense of this ethics of science and technology. The "rehabilitation of practical philosophy" (Riedel 1972) increased the openness of professional philosophy to the moral issues of technological progress. However, it was not until the "principle of responsibility" (Jonas 1979) that a broader public began to take notice of the specialist philosophical debate. Since around the mid-1980s, a boom in the ethics of science and technology can be seen in a large number of publications, conferences, and case studies, the founding of new institutions (Bender/Hartenberger 1997), the establishment of ethics commissions on various topics, and, last but not least, in a differentiation of technology ethics according to subject areas and concepts (Grunwald 1996c, 1998d).

The aforementioned reticence of (social science-oriented) TA toward prescriptive statements is historically due to an ideal of value freedom in the sciences that goes back to Max Weber and was further supported and disseminated by K. R. Popper (Gethmann 1998). As a result, the TA discussion strand remained almost unconnected to the parallel discussion in philosophical ethics on questions of scientific and technological progress, because philosophical ethics sees itself as a normative undertaking. If, on the one hand, there are primarily normative deficits, approaches in philosophical ethics often have operationalization deficits on the other. Instead of a fruitful discussion about the mutual deficits, however, for a long time only an exchange of positions took place (for example, in Grunwald/Sax 1994).

2. Technology assessment as a rational enterprise

The concept of *rational science and technology assessment* can be understood as a critical reflex to the omissions and unreflected assumptions described above, in that it claims to address not only the epistemological questions of the consequences of science and technology, but also and especially their ethical aspects under the claim of scientific rationality. This should not be understood as an attempt to transfer the complex of topics from one subject area (e.g., sociology) to another (philosophy). Rational science and technology assessment is first and foremost an *interdisciplinary* undertaking between the relevant scientific disciplines, and furthermore a *transdisciplinary* interaction between the scientific system in general and the social environment which it presupposes as its basis of life and which it influences (Mittelstraß 1992, p. 120ff.). Rational science and technology assessment is intended to offer operationalization proposals for transdisciplinary problem solutions by methodically reconstructing core concepts of the technology impact debate and thus making them accessible for interdisciplinary work. By explicitly including reflection on scientific languages as the condition for the possibility of interdisciplinary understanding in the program, transdisciplinarity is not primarily understood here as a social event, but as a cognitive achievement and effort that requires reflection on the theory of science. In this sense, transdisciplinarity represents a condition for the possibility of complex problem-solving (Mittelstraß 1989). The fact that science is understood as a problem-solving enterprise means that it makes no sense from the outset to draw a line between cognitive and social endeavors. Epistemology and ethics are two complementary parts of *one* philosophy of science program.

The attribute "*rational*" refers to the need to justify statements and the need to justify actions: Actions should be described as rational precisely when they occur based on action orientations that can be shown to be reasonable or justifiable for everyone (Gethmann 1995). This is based on the conviction that, firstly, normative conflicts are also accessible to rational assessment (cf. Habermas 1973; Gethmann 1982, 1998), and secondly, that the statements of the sciences themselves are not due to the constitution of their subject areas, but to the *processes* of their production. Reflection on the consequences of science and technology therefore also includes – and this also distinguishes rational technology assessment from TA – the reconstruction and critique of the conditions of validity of their results in terms of scientific theory. In the science or technology policy decision-making process, the focus on rationality is reflected in the emphasis on decision-making and planning rationality – this too has hardly been taken into account in the conceptions of TA.

The *concept of technique* underlying here is primarily procedural. The term "technique" refers to both the mastery of action schemata such as, e.g., the technique of playing the violin, or surgical techniques, as well as the relic-like results of poietic actions, i.e., the *artifacts*. "*Technology*" represents the (scientifically disciplined) discourse on techniques, in particular on the ensemble of rules characteristic of a technique. Artifacts are referred to as "devices" insofar as they are used as instruments in other technical practices. The concept of technology thus refers both to "hardware" and to regulated processes. For the reconstruction of technical processes, it should be noted that the methodological primacy always applies to poietic actions over artifacts. In contrast, an "ontology" of technical objects is methodologically secondary.

According to these semantic definitions, bred animals and designed gardens, for example, are also technical artifacts. In terms of the philosophy of technology, there is no obvious difference at this level between a mechanical engineer and a dog breeder: Both produce artifacts for a specific purpose with regard to the anticipated context of use. Of course, this view of the philosophy of technology does not imply any ethical prejudices, such as that a dog should be treated in the same way as a machine. The procedural concept of technology makes it clear that the discussion on the consequences of technology must not only focus on the artifacts as the end products of a research and development process that extends over years or even decades, but that the underlying poietic and scientific processes in particular require reflection. Technology assessment is therefore always also an assessment of the consequences of science and vice versa. This means that, strictly speaking, a distinction between scientific ethics and technology assessment cannot be maintained.

The concept of the *consequences* of technology requires an explanation. First of all, we must remember the distinction between the *result* of an action and the *consequence* of an action (von Wright 1971; Hartmann 1996): The result of the action is the state of affairs that arises after the action has been carried out (after the construction of a production plant, there is a production plant at the location in question). The concept of consequences, on the other hand, refers to other related poietic and practical circumstances (production takes place in the production plant). This concept of consequences is initially neutral with regard to the evaluation of these consequences: Even desired consequences of technology – and this also includes the often neglected *purposes* of technology development – are consequences of technical action in terms of action theory. Purposes are intended consequences, side effects are unintended consequences (this distinction is obviously to be read pragmatically and not ontologically, i.e., it does not presuppose the assumption of a "mental" sphere in which the intentions reside). Opportunities and risks can be subsumed under the concept of consequences. Rational technology assessment is not only concerned with those aspects that are often apostrophized as "side effects", but explicitly also and especially with the justifiability of *purposes* for science and technology.

"*Assessment*" is understood as a rational clarification process that proceeds according to rules to be justified and in this way legitimizes the results of the process.[3] In contrast to the colloquial meaning of "evaluation," emphasis is therefore placed on comprehensibility and trans-subjectivity; at the same time, this implies that assessment procedures can cover both descriptive and prescriptive aspects. In contrast to the concept of technology *evaluation*, assessment focuses on the procedural element and not on the orientation toward material values, however formulated and justified. Rationality assessments are not based on factual acceptance, but on the normative *acceptability* of decisions, which itself can only be determined procedurally. Of social interest is precisely the question of the extent to which it is justifiable *to expect* certain individuals and groups to accept a technical development in the interests of the general public. Distributive justice in relation to opportunities and risks plays a special role here.

The *pragmatic starting point* for all normative considerations are potential and, above all, virulent *conflicts* about how society should deal with the consequences of scientific and technological developments. In conflicts about science or technology and their consequences, the essential future models of society compete; the questions raised are therefore highly relevant in ethical and political terms. Technology conflicts must be distinguished from disagreements regarding the validity of factual assertions and the factual validity of moral judgments (cf., e.g., Renn/Webler 1996, p. 356). Depending on the type of conflict, other forms of discourse must be used to resolve the conflict (rationale or justification discourses). Technology conflicts and related decision-making uncertainties are essentially generated by the different moral concepts of those affected. In rational technology assessment, different morals should be worked through with the available means of practical rationality in order to judge the desirability or acceptability of the consequences of science and technology.

Rational management of conflicts surrounding science and technology is an essential prerequisite for long-term reliable science and technology policy. Rational technology assessment therefore aims to provide the means to offer *advice* within the framework of the possibilities for preparing decisions and reflecting on technology and science. The addressees of this advice are:

- Political bodies and institutions that either regulate the framework conditions, guide the progress of scientific and technological development through funding measures, or directly intervene through state technology decisions;

3 *Editors' note*: This understanding of ethics has recently been unfolded as a foundational philosophical monograph (Gethmann 2023).

- Professional groups and individuals who are involved in shaping scientific and technological developments in the course of their work. This applies in particular to the self-regulation of the scientific system;
- The general public, communicated via multipliers and the media.

This advice also relates to the problem of how a long-term, reliable technology and research policy can be designed and implemented. The prudent use of society's scarce financial and human resources requires a forward-looking, long-term, and sensible approach to scientific and technological development. Serious course corrections at an advanced stage of major scientific and technological projects, on the other hand, often require considerable economic resources; breaking-off lines of development leaves behind investment ruins and can result in considerable legitimacy problems. Rational technology assessment therefore ideally refers to the research and assessment of the consequences of science and technology at the *earliest* possible *stages* of their development, in which social control measures are still effective without serious economic consequences, and acts as a reflection to accompany science and technology.

The focus on long-term orientations in the shaping of scientific and technological progress means that rational technology assessment – unlike the advisory services of parliamentary TA institutions, for example – is less geared toward *direct* implementation in concrete decisions. Instead, it is intended to allow perspective assessments of the realms of possibility in which scientific and technological developments occur. It is therefore *practice-oriented*, but not directly *implementation-oriented*.

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