Chapter 2
Responsibility in Science: The Philosophical View

Hans Lenk

Abstract Terms of responsibility are relational attributes, i.e., attribution terms. They are to be understood as linguistically, socially, and situationally embedded concepts conventionalized by rules and have to be analyzed accordingly. A structural theory of responsibility, and more differentiated forms and types of responsibility such as relational attribution-based concepts, will be developed schematically in order to do justice to the variety of different uses of the concepts of responsibility, e.g., causal and action responsibility, role responsibility, but also social and (universal) moral and legal responsibility. In this chapter, I apply the general considerations of responsibility to analyze responsibility in science. The responsibility of the researcher in science and technology is a special case of role-specific and moral responsibility in a strategic position. Points to be discussed include known means of implementing responsibility in science, including codes of conduct, ethics committees, a scientific ethos, and the Hippocratic Oath for scientists. The chapter concludes with fifteen theses on responsibility in science. The key principle should be "concrete humanity": Practical and concrete humanity should always be a central guiding principle (in dubio pro humanitate practica).

Terms of responsibility are relational attributes, i.e., attribution terms. They are to be understood as linguistically, socially, and situationally embedded concepts conventionalized by rules and have to be analyzed accordingly.[1] A structural theory of responsibility, and more differentiated forms and types of responsibility such as relational attribution-based concepts, will be developed schematically in order to do justice to the variety of different uses of the concepts of responsibility, e.g., causal and action responsibility, role responsibility, but also social, (universal) moral and legal responsibility. These are such complex terms that it is not possible to make an overall general classification. Different types of responsibility would structure the social and normative reality differently and have specific implications. The

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attribution of responsibility itself can be either descriptive or normative; in such context, it is to be understood as descriptive or normatively acting. Both functions must be carefully (ideally) distinguished in any analysis, even if in practice both attributions are usually made at the same time. Nevertheless, a distinction has to be made between normative and descriptive use(s). Diagrams of, e.g., role and task responsibility as well as moral, legal, and other specific variants, may further subdivide the abstract scheme types or serve for further concretization. The same applies to analytical–structural polarity of responsibilities and to priority rules for handling typical conflicts among some such responsibilities regarding different instances or role-takers. Newer concepts such as social, collective, and corporate responsibility and even system responsibility will require more attention in the future. Even if these analyses are still incomplete, I shall attempt in the following an application to the responsibility in science.

Introduction

In his Dictionary of the Devil (1911) the great satirist Ambrose Bierce defined:

> RESPONSIBILITY: a detachable burden easily shifted to the shoulders of God, Fate, Fortune, Luck, or one's neighbor. In the days of astrology, it was customary to unload it upon a star.

Today, some people would actually rather shift the responsibility to a *star* (in the new societal sense), be that a star of politics, society, or even science. However, although scientists were traditionally considered responsible for "clean" scientific work (today: "good scientific practice") and for successful discoveries, they were not considered responsible for the practical and social consequences, technical developments, and applications resulting from them. Basic researchers, in particular, saw/see it this way.

In 1994, Nobel Prize winner Rudolf Mößbauer said: "In the field of basic research you have no responsibility at all."[2] However, he added that it would be "different" for applied physics. The Nobel Prize winner Klaus von Klitzing also emphasized that the scientist would only be responsible for the validity of the research results—not for the practical applications by others. And he added: "After all, basic research cannot be banned."[3]

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[1] Types of responsibility in general and specific responsibility(ies) are analytically understandable (quasi ideal-typical) concepts or, in part, normative constructs of interpretation, which often "overlap" in social reality to the extent that several of the typological constructs are often applied simultaneously—in varying degrees—for description and analysis. This makes clear the interpretive character of the attributions of responsibility in particular. (Nevertheless, the attributions usually have considerable social reality, because they are based on social norms, some of them supra-individually binding or even sanctioned).

[2] Mößbauer (1994), see also Lenk (2015, p. 337).

[3] See Lenk (2015, p. 337).

Albert Einstein, however, was of a different opinion. He wrote to Max von Laue, also a Nobel Prize winner, in the 1930s:

> I do not share your view that scientific man should remain silent in political, i.e., human, affairs in the broadest sense. You can see from the conditions in Germany whereto such self-restriction leads. It means leaving the leadership to the blind and irresponsible ones—without resistance. Isn't there a lack of responsibility behind all that? Where would we be if people like Giordano Bruno, Spinoza, Voltaire, Humboldt had thought and acted like that?[4]

Einstein, as a newly appointed member of the Prussian Academy in the last century, proposed the foundation of a chair for philosophy of physics during a lecture at the "Friedrich-Wilhelm-Universität" in Berlin (now "Humboldt-Universität zu Berlin"). He obviously did not only mean in this later letter just the responsibility for methodologically sound scientific work, but much more generally the purview and "feeling" of a much greater, generally human responsibility—before one's own conscience facing the ethical "moral law" (Kant) and the (idea of) humanity or society—in any case towards an internal and/or external instance.

Accordingly, a clear distinction is rightly made between the so-called external and internal responsibility of scientists. Even today, however, scientists too easily confuse or confound internal and external responsibility. However, moral responsibility—directed towards those potentially affected by actions on the one hand and the traditional *guild ethos* of the scientist on the other hand—should also not be confused here.

The *ethos of* the scientific guild and the "internal" "responsibility of the scientist" are not ethical in the strict sense. Ethos presupposes ethics, but is not ethics. The respective codes of standards of the scientific associations, for example, are in this sense *ethos*, not universal *ethics* of the scientist or even science. Unfortunately, this is often still mixed up. Despite some recent scandals, the ethics of the guild, the ethos system of science, generally works quite well.[5]

The scientist himself usually tends to retreat to the rather narrowly understood *ethos:* Only the best possible, efficient, clean, truthful research ("good practice") and honest, non-deceptive recording and publication, as well as fair treatment of his rivals, etc. would be his responsibility. But this is not enough, for example, when it comes to so-called "human experiments" (experiments on humans, whether performed individually or collectively) or "field experiments" in which people are directly affected or when the transition to applied research becomes fluid. The separation of basic research and applied research has become much more difficult today, sometimes even impossible; Just think of today's genetic engineering.

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[4] See Herrmann (1977, p. 115, translated). Herneck, a science historian, summarized—also with regard to Einstein's later statements after the atomic bombing of Hiroshima and Nagasaki—as follows: "Albert Einstein is a brilliant example of a scholar who has grasped the problem of the responsibility of the natural scientist and technician in the atomic age in all its depth and is striving to do justice to it" (1977, p. 401, translated).

[5] Cf. Lenk (1991, p. 57 et seq.).

According to Einstein, however, scientists may also bear *external and social* responsibility.

Even the ambivalence of the positive and negative, destructive usability of technical and scientific results can no longer be resolved so smoothly and easily as traditionally thought: also, if responsibility grows with power and knowledge, then the co-responsibility increases accordingly with both.

Is the excuse of the well-known biochemist José M. R. Delgado—namely, "I am not an ethicist, I am a biologist"—generally sufficient to "de-excuse"?[6] A certain co-responsibility of the scientist providing the procedures can be given on a case-by-case basis, which is particularly evident in the negative case: The scientific developer of napalm, Louis Fieser, of course, like the later so-called "father of the hydrogen bomb", Teller, rejected any ethical co-responsibility, although the latter had previously reported his torments of conscience in a letter to Leo Szilard.[7]

Power, ability, and knowledge obligate us. "Everyone has a special responsibility where he has either special power or special knowledge."[8] Karl Popper would like to activate responsibility through an oath-like "promise" oriented on the Hippocratic Oath of the medical profession. It turned out that the idea of the Hippocratic Oath is problematic. It is good as an idea, but has a low effectiveness, (too) low controllability and enforceability. It does not take or enforce enough real political, practical action. It is at best ideal-typical. It may hardly work effectively in field and human experiments. Different rules should probably be used for the application of the results of completed research in social practice.

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[6] Cf. Lenk (2015, p. 343).

[7] In this letter to Leo Szilard dated July 4, 1945—that is, before the nuclear bombs were dropped on Japanese cities—Teller wrote, "I have no hope of clearing my conscience. The things we are working on are so terrible that no amount of protesting or fiddling with politics will save our souls. This much is true: I have not worked on the project for a very selfish reason and I have gotten mucsh (sic!) more trouble than pleasure out of it. I worked because the problems interested me and I should have felt it a great restraint not to go ahead. I can not claim that I simply worked to do my duty. A sense of duty could keep me out of such work. It could not get me into the present kind of activity against my inclinations. If you should succeed in convincing me that your moral objections are valid, I should quit working. I hardly think that I should start protesting. But I am not really convinced of your objections. I do not feel that there is any chance to outlaw any one weapon. If we have a slim chance of survival, it lies in the possibility to get rid of wars" (Teller, 1945). So Teller only hoped for the deterrent effect. (And perhaps the historical development in retrospect has even proved him right in this respect…). Szilard, on the other hand, relied on the general worldwide publication of the research results and some kind of automatic check-and-balance solution to the problem. Is Teller's statement only impotent cynicism, deportation of all morality and justification (possibly unconscious strategy of self-justification, a so-called rationalization)? The letter rather speaks for conscious moral fatalism or defeatism—as if nothing more could be done. Have scientists and technicians today become the bearers of a pact that is no longer Faustian but downright diabolical, a vicious circle at least, which, as Robert Oppenheimer said, has led them to the edge of the abyss of presumption? Have they now learned to know utmost sin, have they even sinned in doing their research?

[8] Popper (1977), p. 304, translated.

One often refers to so-called "ethics committees." These should not only be used in medicine, but for all sciences. It seems doubtful, however, whether a permanent ethics committee could be in charge of investigating and assessing the ethical, social, legal consequences of basic research and progress not only in biomedical research, but in technology and science in general. How should it be the appropriate institution to steer and reliably scrutinize science, even if this committee were interdisciplinary and broadly based? It would indeed be absolutely overstressed and overcharged. Ethics committees in biomedical research, as in all direct human experiments, may be useful and in order for monitoring purposes, whereas a comprehensive overall commission would probably find itself overburdened in dealing with all the overarching problems of basic research. Instead, these issues need to be addressed politically.

However, science must not be unnecessarily hindered or prevented. So far, there are no effective overall remedies for all-round solutions to such conflicts. One should do everything possible to raise awareness of ethical conflicts and not blindly suppress ethical considerations by retreating to career interests, which is indeed a systemic pressure in the unrelenting competition for career progression! (Just think of the German cancer researcher scandal, or the data manipulation by a young German physicist or a Korean stem cell researcher, and most recently Chinese genetic manipulation of embryos).

Incidentally, it is usually not a matter of assigning responsibility solely to individuals, but of (bearing) joint responsibility, of sharing the responsibility in groups, etc. The extended responsibility in view of the Faustian pact on scientific and technological progress, which has been entered into and is no longer easy to revoke, is indeed more important than a traditional moral responsibility for "good scientific" basic research, which can hardly ever be attributed retroactively.

The responsibility of the researcher in science and technology is indeed a special case of a role-specific and moral responsibility in a strategic position. Preventive responsibility must be taken into account wherever harmful effects can be anticipated and possibly be averted. A personal co-responsibility may exist on a case-by-case basis, but a general strict or even sole responsibility of the scientists and technicians for the causes across all cases does not exist in view of the ambivalence and collective origin of research results, especially in basic research. In most cases it is a question of co-responsibility, which should be specified in more detail. We have to find viable middle solutions. All the more important is the preventive view to prevent destruction and permanent damage in advance, if ever possible. In view of the dynamics of development and the difficulties of orientation and evaluation in this whole problem area, the only realistic approach seems to be to promote the sense of moral co-responsibility as far as possible and to discuss it, for example, by means of case studies.

Responsibility as a Relational Concept of Attribution

A Conceptual and Methodological Overview

Terms of responsibility are ascribable or attributed in the form of multi-place predicates (i.e., relational) or structural terms,[9] schemes requiring analysis and, interpretation with the following elements:

- *somebody*: responsible subject, bearer (person or institution, corporation, etc.) is responsible[10]
- *for*: something (actions, sequences of actions, states, tasks, etc.)
- *towards*: an addressee
- *before*: a (sanction or judging) instance
- *in relation to:* a (prescriptive, normative) criterion
- *within the framework of an* area of responsibility, area of action, etc.

Responsibility is thus initially a concept that is expressed in a relational norm of attribution through the evaluation of a controlled expectation of action. Accountability means that someone has to justify their actions, consequences of actions, conditions, tasks, etc. towards or before an addressee to whom (s)he is accountable and before an authority—according to relevant and extant social, legal, or moral standards, criteria, norms, etc. The person responsible in each case has to justify their actions and decisions, etc., vouch for and be responsible for their own actions and those of others, if specific conditions are met. Moreover, "responsibility" is not only a descriptive term—it is normatively established that someone bears responsibility—to be used, but above all also a concept that can be ascribed in an *evaluative way*: Someone is held responsible, held accountable—which opens up the normative, and thus ultimately the ethical dimension of action. Depending on the type of responsibility, a conventional, social, normative, or descriptive language game is opened or "played." Responsibility by attribution or description is a social construct of interpretation embedded in institutional contexts. Responsibility is relative to the system of norms, is attributed in a context-, culture-, language, system- and theory-related way. (Finally, the functional attribution and disposal methods of the linguistically and socially embedded occurrences of concepts and statements of responsibility would also need to be analyzed more closely).

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[9] Lang (1985, p. 262), who develops a structural model of legal philosophy, writes that "the formulation of an analytic definition of legal responsibility seems not to be possible" and that responsibility "has many meanings in the different branches of law". However, there is a "core meaning" with some "necessary structural elements": "the bearer of responsibility," "the receiver of responsibility" and "the object of responsibility." See also Neumaier (2008).

[10] Secondary distinctions that do not belong within the concept of relationship itself (as an element) could be: responsible with regard to a point in time: ex ante, ex post; threatened with sanction: formal, informal; with varying degrees of binding force, corresponding to mandatory (must do), target (should do), and optional (can do) norms.

The *attribution of responsibility is thus multidimensional*: it can attempt to determine the causation, the action (consequential) responsibility in a descriptive manner; it can also attribute other types of responsibility in a descriptive manner. Yet, it can also normatively attribute either legal liability and guilt or moral reprehensibility or praiseworthiness. Different types of responsibility are now obtained by (a further) interpretation by a differentiating or specifying allocation of the general scheme of responsibility, the relationship links as mentioned, etc.

To speak of a single concept of responsibility, a single meaning *of the* (total) responsibility, does usually not do justice to the different interpretations, interpretations, or reference perspectives. Different types of responsibility and correspondingly different concepts of responsibility must be analytically distinguished. But they are possibly related, compared, assessed against another, and possibly brought together personally or by "coordination" in "parts" or partial aspects into an integrated overall or "composite responsibility" (see below).

Within the framework of the "usage theory" of meaning (Wittgenstein), Neumaier (1986) examined the concepts of "responsibility" and "conscience". He distinguished different ways of using the concept of responsibility in different meanings depending on which criteria we take as a basis, since we only ever "capture certain aspects" (p. 215). Characteristic of the different ways of use are *family similarities* in the sense of Wittgenstein (p. 217). One can distinguish, among others, the following pairs of meanings (loc. cit.):

- Descriptive and normative use of "responsibility"
- Individual and collective responsibility,
- Also collective and corporate responsibility (cf. Maring, 2001),
- Responsibility for someone who can or cannot assert or uphold certain rights against the actor,
- Moral and legal responsibility.

(The list could of course be extended; see the sections below)

Normative vs. Descriptive Use

With regard to concepts of responsibility, especially with regard to the ability to take over and bear responsibility and characterizing humans as the responsible beings per se in philosophy and empirical social sciences, two aspects should be clearly distinguished: Ethically, the ability to take and bear responsibility is a normative prerequisite, which can be assumed to be virtually independent of experience, in the sense of the moral person's ability to act differently, which is not necessarily meant empirically, i.e., the presupposed freedom for self-determination and for the corresponding imputation.[11] The preconditions are mutually related and interdependent:

[11] Depending on the (area of) responsibility, this prerequisite is considered to be given or fulfilled in different ways for (real) persons—if necessary, also graded as in the law (e.g., children who have not reached the age of 7 are not tortable; adolescents who have not reached the age of 18 are only tortable in a limited sense [German law, § 828 BGB]).

the normative definition and its validation leads to the empirical question of the existence of the extant preconditions. Normative specifications are thus based on criteria whose fulfilment can or should be empirically verifiable; in practice, however, it is hardly possible to do something without some form of evaluation.

Thus, within the words of Mackie (1977), it is "factual, psychological, question whether an action is intentional or voluntary" (p. 208). However, it is/will "be a moral or legal question whether or in what ways an agent *is to be* held responsible" (loc. cit., added emphasis). It is also an empirical question to what extent individual actions or certain types of actions meet criteria/conditions of responsibility (cf. p. 215). However, the "straight rule" of attributing responsibility links both problems together: an agent responsible for all and only his/her "intentional actions" (p. 208). We occasionally deviate from this principle: there is—often in exceptional cases or on the fringes of the "family-like" concept areas—also responsibility without intention (e.g., in the case of strict liability) and intentional action without legal and moral responsibility: Thus we consider children "legally and morally less responsible for what they do", even if there is "no general lack of intentionality" in their actions (p. 212 et seq.).

Like Ingarden (1970, p. 5 et seqq., translated), who distinguished between "being responsible", "assuming responsibility," and "to be held responsible" and emphasized the actual "independence of these facts" and their "context of meaning", Ströker (1986, p. 196 et seq., translated) also separated the bearing/having of responsibility and its assumption as well as the context and the normative conditions, "which exist between the individual determinants of the concept of responsibility and their situational moments": Thus, on the one hand, these are "de facto independent of each other": one can have a certain responsibility and yet not take it over and possibly not be called to account. On the other hand, Ströker claims that "one can be held responsible for something without being responsible for it. Also, one can take responsibility without really having it." In spite of this "de facto independence" there are "idiosyncratic" ethical connections: "As soon as one has or bears responsibility for something, one can also, in principle, be called to account and should not eschew one's obligations." Furthermore, "taking responsibility for something for which one does not have, it may well be necessary, but in other cases it may be morally illicit." In this respect, "an abstract general standardization is not possible," but perhaps a more precise definition of the relationships might be.

Types of Responsibility

At least the following types of responsibility can be distinguished, for example (cf. detailed Lenk & Ropohl, 1987, p. 115 et seqq.):

- Responsibility for consequences of *action or causal responsibility* for one action(s); in a slightly modified sense as
- Liability (for damages); then probably rather as a special case of
- *Legal responsibility*,

- *Role or task responsibility*,
- *Moral responsibility*,
- Pedagogical responsibility,
- System responsibility
- (Reflexive) meta-responsibility
- As well as higher-level "*composite responsibility*" with possible overlappings or gradings of special responsibility (types) (see priority rules below).

I would now like to present the corresponding diagrams[12] of the types of responsibility, which I have already dealt with frequently but shall to comment on only very briefly here.

First of all, the fact that someone is responsible for his or her actions or the consequences of their actions can be understood in many ways (see Diagram 2.1). Firstly—and this is the normal situation—it applies that one causes and brings about one's own actions and is therefore (mostly) responsible for them and for the corresponding consequences. This is the (*positive*) responsibility for action. However, there are also omissions, and thus a corresponding *negative* causal responsibility for

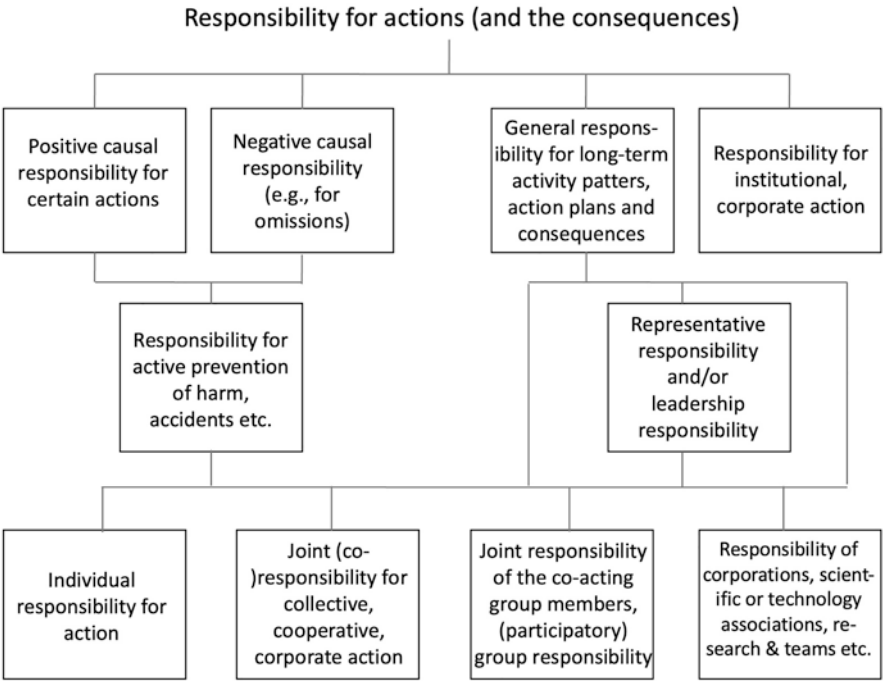

Diagram 2.1 Types of action responsibility (including the responsibility for consequences)

[12] First probably published in Lenk (1982), but also, e.g., in Lenk & Ropohl (1987), Lenk (eds.) (1991); Lenk (1992, 1996, 1997a, b, 2006, 2015); and in English in Lenk (2005/2015, 2007, 2019).

action. And there is also the *combination* of both, namely in active responsibility for prevention and protection which, for example, the test engineer or the control scientist must assume in the practice of applied sciences, as does every supervisor in any field whatsoever. This is of course a responsibility that is particularly characteristic of some engineering activities. Then there is also the responsibility for longer-term actions, sequences of actions, series of actions; parents are responsible for their children, for example, etc. Finally, a responsibility for institutional, for corporate action must also be listed, a kind of responsibility that also applies to companies, institutions, or is exercised by representative and leadership responsibility: When one acts as a representative of a corresponding group, society or, for example, a state institution, then one is acting "representatively" in a specific leadership role, as a leader; and this is a kind of responsibility that must be analytically separated from direct personal responsibility. Furthermore, there are of course some overlaps, conflicts, questions of co-responsibility, etc. Diagram 2.1 is of course still a somewhat abstract scheme that needs to be filled in more closely and substantially.

One of the most characteristic substantiations is of course what we call *professional or, more generally, role and task responsibility* (see Diagram 2.2). Everyone who is active in a role has role duties, and must fulfill or execute them responsibly. This can be formal or legal or prescribed; but it can also be informal, by habit, by appointment, or something similar. This is also the case for job-specific task

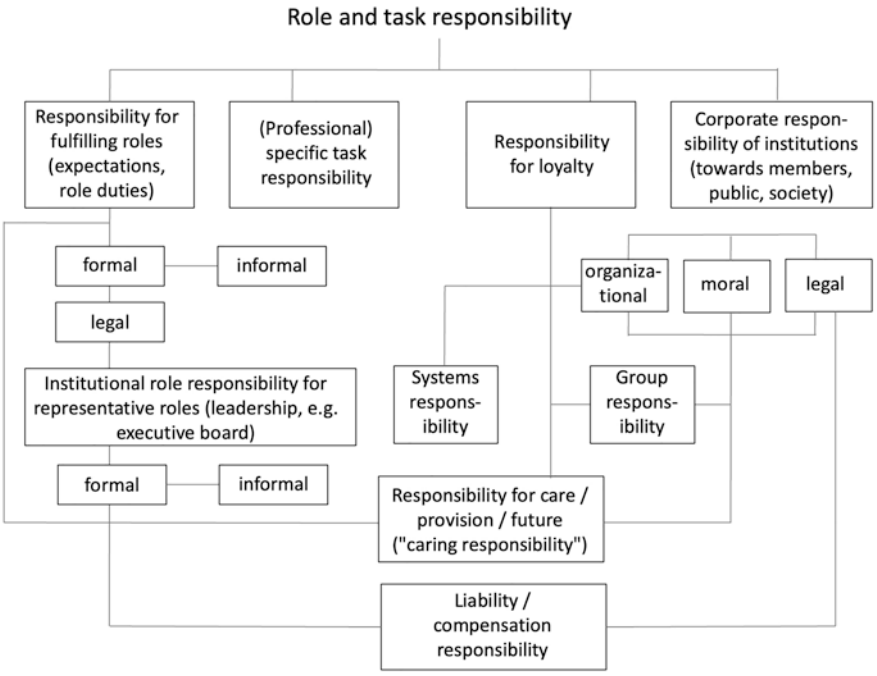

Diagram 2.2 Role and task responsibility

responsibility, for example, which refers to a very narrow job description or similarly defined role. But, independently, there is also a personal responsibility of loyalty, e.g., in politics towards the "elder statesman" and similar personalities or authorities (e.g., the state or the people). (These are responsibilities which are not formally concretized in any way, but that nevertheless exist). There is also, unequivocally, a corporate responsibility of the state towards its members or citizens, and the corporate responsibility of companies, e.g., towards members and customers—both in a legal context and certainly also in the fulfilment of tasks, etc. Yet, there is also the problem of whether such actors can also have a special (*corporate*) *moral* responsibility in this respect.

What is particularly interesting here is that one can also, for example, have a mere liability responsibility, i.e., a responsibility for actions and things that one has not caused oneself, where one is only liable or has to accept responsibility, e.g., parents for their minor children. Worthy of special mention is the responsibility for welfare and precaution, which Hans Jonas focused on in his book on *"Das Prinzip Veratwortung"* (1979, English title: "*The Imperative of Responsibility"*), in which he emphasized an *expansion of* responsibility (or the concept, respectively). Jonas considers that the traditional concept of guilt responsibility should be abandoned and instead be replaced by an expanded concept of responsibility in terms of power or existence dependency: Children are dependent on their parents and the parents are responsible for the dependent children in *general*. And so in general the more powerful person is always responsible for the dependent one. Of course, it is not justifiable that this is now *the* responsibility that is supposed to replace the "old" guilt responsibility, as Jonas had originally claimed. He then realized in subsequent discussion with me that this must be changed: The traditional responsibility for one's own actions, i.e., for one's present and past well- and wrongdoings etc. as well as for one's own future actions (Jonas: "that which is to be done") naturally remains. But according to Jonas, the *responsibility for care* is indeed an ethical extension (or at least necessary accentuation) of responsibility. Incidentally, at the same time as Jonas emphasized that shift, I had already emphasized that "extended possibilities for action" also generate "extended responsibilities" (Lenk, 1979, p. 73).

Of course, one could give many more examples, especially from science and technology; I do not wish to do that here, but only refer to the examples mentioned at the beginning.

Pure *moral responsibility*—I refer instead to *universal moral responsibility* in order to distinguish the real ethical responsibility from the extant moral(e) (which, for example, the Mafia also has in its codes of conduct, as is well known, and a very strict one)—is that which applies *equally* to *all* in all comparable positions and situations (see Diagram 2.3). This is often activated by direct situations, action situations, decision situations, etc. Here, also the previously mentioned responsibility for care and precaution for one's dependents in the sense meant by Jonas naturally also comes up again.

However, there is also *indirect* responsibility for the possible consequences of one's actions or omissions, for example, as remote consequences. For example, there are relations between highly industrialized countries; for example, in the case

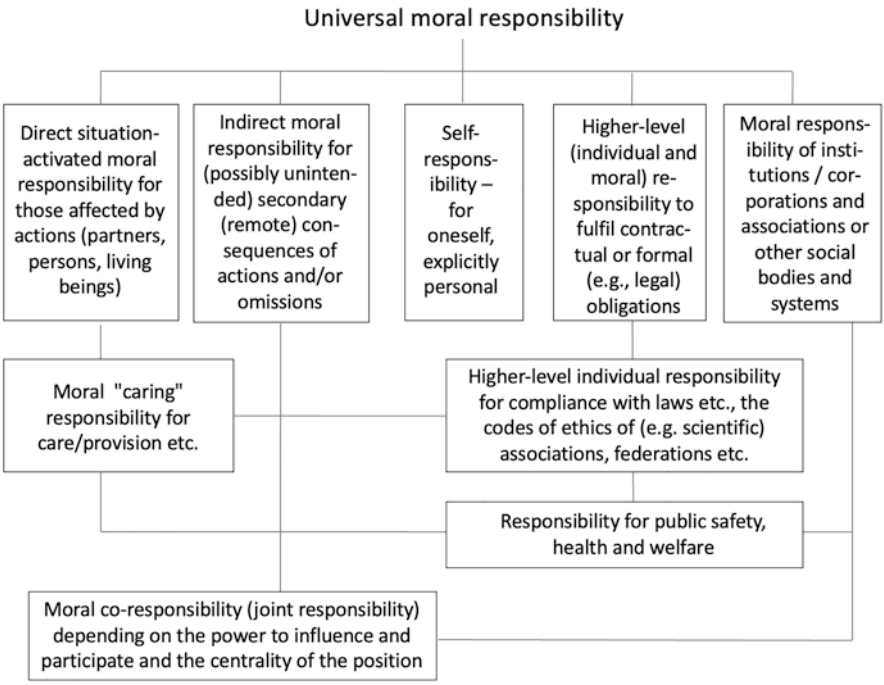

Diagram 2.3 Universal moral responsibility

of coffee prices and coffee producers in developing countries, there are economic survival problems that lead to livelihood problems for coffee farmers, etc. These responsibilities here are quite similar to the corresponding role and task responsibilities, only here they are related to the truly ethical problem, to that which concerns the welfare and woe of other persons—or even other living beings, e.g., pets—and thus concerns the ethical–moral proper.

There is also a *higher level of* individual responsibility to fulfil certain moral or other contractual, legal, or formal obligations. For example, I have a moral obligation to abide by the law. This is a higher-level moral obligation, such as the obligation to comply with special laws, to assume certain subordinate or lower-level responsibilities. The question of whether there is a moral responsibility of institutions, companies, or corporations is a hotly debated one. I mean that such a responsibility indeed exists. But I hold that this responsibility cannot be understood in the way that some American scholars (e.g., French, 1984) present it; they see the corporation as a "moral person" comparable to a legal person. But this is something that can and should be talked about and discussed.

An important passage for technicians and scientists is the following: There is a responsibility to comply with the codes of ethics and the corresponding standards that make up the ethos of the respective associations and those that relate to

responsibility for the general public: in the US since 1947, all codes of ethics have included the responsibility for maintaining or ensuring "public safety, health and welfare."

In law, the situation is quite difficult because different areas of law have different concepts, including tort and liability (and not only, for example, family relationships in the case of paternity or inheritance, which vary between different areas). We have not yet found a really clear picture of the typology of legal responsibilities. However, we can say: A norm addressee is responsible to the authorities to which (s)he must answer, depending on subjective preconditions, graded according to degrees of responsibility and with various legal consequences, in particular sanctions. For example, the following responsibility-relevant elements can be found in German law:

1. Addressee of the norm: e.g., in criminal law: individuals; in civil law: natural persons and legal entities for their organs.
2. Instances: e.g., in criminal law: courts; in civil law: individuals, arbitration bodies, courts.
3. Subjective requirements: e.g., culpability, intent, negligence, warranty for purchase and work contracts, (strict) liability.
4. Characteristics of responsibility: e.g., behavioral responsibility for action/inaction (or intentional omission); role responsibility: e.g., contractual, parental custody, restricted or specifically limited responsibility.
5. Legal consequences, in particular sanctions: e.g., without sanctions (fully / partially released from responsibility); with sanctions: positive (tax benefits, subsidies); negative (liability, penalties).

In most cases, even in the case of engineers and scientists—especially in applied research—responsibility refers to specific roles and often to *conflicts* between such roles, duties, and expectations and their various responsibilities, and to corresponding distributional issues. The engineer as a person has to deal with different corresponding institutions, e.g., with clients, customers, or employers; one's own company or a foreign one, etc.; with corresponding public institutions or the profession itself, i.e., the respective association etc.; or with society in general.

Accordingly, *conflicts* can naturally develop between different loyalties and responsibilities; this is even quite typical. Such a conflict of responsibilities arises, for example in situations that remained common during the Last century, where a company or employer might demand of an employed engineer that this subordinate coworker should dump waste into the Rhine river or into the air, for example at night, which is of course contrary to the interests of the public and (more recently) of course illegal under environmental law. Such a situation naturally leads to a personal conflict of responsibility. What is the poor engineer supposed to do? The conflict may be difficult to bear or to solve—sometimes with serious consequences for the employee. That is why we have considered whether there are certain regulations or possibilities to address such conflicts. I would like to try to shed light on this with the following rules for listing priorities and preferences.

Certain ideas for conflict resolution may be adopted from American business ethics (these are the first four rules): In essence, these first rules say that there are basic moral rights, in particular Human Rights, that are inviolable; even our Constitution already says this. In addition, there is a plausible demand that considerations of benefit and acceptable livelihood and public as well as private health and societal Commons must be taken into consideration in referring to these fundamental rights—in particular if there are insoluble conflicts between fundamental rights or some extant equivalent rights. For example, fair compromises should be sought: after weighing up the moral rights of each party, some kind of compensation should be found, with some kind of decent proportionality. Only after these rules have been applied should one weigh the anticipated benefits against those of doing or causing harm to others. This is a consideration that frequently occurs in business ethics and can be summarized in such a way that one should take into account non-surrenderable moral rights before averting and preventing harm and these before considerations of benefit. In practically insoluble conflicts, therefore, an attempt should be made to achieve an equal distribution or "fair" proportion of the corresponding distribution of burdens and benefits. Universal moral responsibility should therefore generally precede task and rule responsibility or role responsibility. The public good should take precedence over individual interests.

Box 2.1: Twenty Priority Rules[13]

1. Weighing up the moral rights of each individual concerned; these take precedence over considerations of benefit (predistributive, basic rights).
2. Seek a compromise that takes everyone equally into account; in the case of an insoluble conflict between equivalent fundamental rights.
3. Only after weighing up the moral rights of each party can and should one vote for the solution that causes the least damage to all parties.
4. Only after 'application' of rules 1, 2 and 3, then weigh up benefits against doing or causing harm. In other words, *moral rights that cannot be abandoned take precedence over averting and preventing damage and the latter over considerations of benefit.*
5. *In the case of practically insoluble conflicts between parties and those involved, certain fair and humane compromises should be sought with regard to the harm and benefit to the various parties*. (Fair compromises are, for example, approximately equally distributed or justifiably proportioned, sharing burden and benefit).
6. Universal moral and direct moral responsibility takes precedence over non-moral and limited obligations.
7. Universal moral responsibility usually takes precedence over task or role responsibility.

(continued)

[13] The first four rules are taken from Werhane (1985) , pp. 72–3.

Box 2.1: (continued)

8. Direct primary moral responsibility in the action or decision situation is usually given priority over indirect remote responsibilities (because of the urgency and limited obligation; but: evaluations and gradation are necessary according to the severity and sustainability of consequences).
9. Universal moral and direct moral responsibility take precedence over secondary, e.g., corporate responsibility.
10. The public good—the common good—is to prevail over all other specific and particular non-moral interests.
11. In the case of safety-related design, preference shall be given to the solution by which the protection goal is best achieved in a technically sensible and economically viable manner. In case of doubt, safety requirements take precedence over pure economic considerations.[14] Safety therefore comes before economic efficiency.
12. *Global, continental, regional, and local environmental compatibility must be distinguished and taken into account. System-relevant / decisive environmental compatibility takes precedence—and, in this extreme type, the more sectoral or comprehensive (*cf. the climate crisis*).*
13. *Ecological compatibility and sustainability take precedence over economic use,* except in cases of immediate "urgency" (e.g., famine, epidemics or even pandemics, or other humanitarian disasters).
14. *Human, humane, and social compatibility take precedence over environmental, species- and nature compatibility in individual cases of conflict,* but are usually to be *striven for* together or *in sensible compromises.*
15. Concrete humanity takes precedence over abstract demands and universal principles (concrete humane and socially acceptable weighing of goods).
16. Humane (human and social compatibility) concerns take precedence over the merely factual.
17. *Compatibility with the requirements of survival and the quality of life of future human generations and the predictable acceptance of measures affecting future generations should be given very high priority.*
18. In social and political planning in general, every effort should be made to achieve a (relative) maximum of general freedom and freedom of choice—openness and flexibility of planning on a large scale—and to achieve largely equal opportunities for future developments ("multi-option society").
19. *A relatively wide range of options should be given high priority for present and future generations, i.e.,* no important options should be excluded for present and future generations. *It is therefore necessary to avoid total*

(continued)

[14] This rule refers to technical regulations by DIN 31 000 (ISO 51: 1999).

Box 2.1: (continued)

resource depletion and extensive environmental pollution by giving priority to "sustainable development" everywhere, which neither overtaxes nor undermines the "load-carrying capacity" of ecosystems (and especially of the entire ecosystem of the sphere of life)—nor runs counter to the fundamental rights and participation rights of large population groups. It is therefore imperative to achieve a proportionate and morally acceptable combination of the requirements or priorities of Rules 16 to 18. Rule 19 refers to the compatibility of today's so-called "multi-option society" and the "sustainable" use of natural reserves and resources without overexploitation—both for present and future generations. In a way, it combines the two rules mentioned above into a demand for a balanced and fair compromise for all parties concerned—both present and future. *"Sustainable development" for present and future generations should be a very high priority. The idea of the "sustainable" use of resources with renewable raw materials of all kinds, that has met with great international acclaim (even if it has not yet been realized), should therefore be further supplemented by the demand for the non-total exhaustion of non-renewable resources and by the search for alternatives that are as environmentally friendly as possible. In particular, highly important organic raw materials such as petroleum, for example, which should still be available for future petrochemical syntheses and developments and thus for important products for future generations, should not continue to be burned uncontrollably by combustion engines in ever in-creasing amounts.*

The current possible freedoms of multi-option societies must be preserved in an appropriate manner and, if possible, also for future generations, and that they must be given access to a reasonably distributive assurance of the conditions of existence (the minimum standard of living beyond the physical subsistence level). Not only a "natural" but also a morally "acceptable," i.e., humane and humanitarian, form of development should urgently be aimed for. A combination of the latter two rules should be sought for both present and future people in an appropriate manner as emphatically as possible and as "sustainably" as possible.

In cases of urgency, ecological compatibility and/or sustainability should usually take precedence over purely economic interests and application.

Finally: *Concrete humanity*—the concrete-human combined responsibility mentioned above—takes precedence over abstract demands and universal principles. This means that the corresponding decision in an urgent or emergency situation comes first: here, I would say, the human or humanitarian benefit or responsibility for the people involved even takes precedence over environmental compatibility in the broader sense, although the two are generally closely related in the end.

The Necessary Personal Integrated Balance of Responsibilities

Concrete-human responsibility, including for the consequences of developments in complex systems, can neither ethically nor legally be borne out by a single individual alone. Of course, this also applies to the ethics of technicians and scientists. However, it cannot be assigned in an abstract way to the human *species as* such or to the professional category of engineer or manager. Yet, medium solutions according to the respective situation or role are, as a rule, dependent on the centrality, decision-making power, or potential impact, and on group responsibilities, etc. They are to be developed in a graduated sequence or, in the case of conflicts, dimensioned according to the viewpoint and imperative of concrete humanity. No one can be responsible for everything. Responsibility is not all-encompassing, especially not in the age of networked systemic contexts, where the problems of distribution of responsibility and multiple allocation are particularly difficult; For example, who is responsible for the information on the Internet?[15] But neither can we ignore humanity, humanization, in the form of really humane measure(s). That, though, is all too easily forgotten in these contexts. And humanity becomes effective only in concrete terms. *Humanitas concreta praestet!* (Concrete humanity has priority).

In summary, I would like to assert that personal moral responsibility continues to be the prototypical example, the model of responsibility. But that personal responsibility is no longer the sole responsibility. Although individual moral responsibility is the prototype, there are also responsibilities of collective actors and of formally organized secondary actors (institutions, corporations, enterprises etc.), i.e., a secondary responsibility, so to speak, for organizational, corporate action, which must, however, *always* be seen *in connection* with personal responsibilities, with the "ethics of the personality" to which it cannot, however, be reduced completely. It is and remains a difficult, precarious problem to keep alive the connection between the more abstract organizational levels from the "ethics of society" with its implied and possible systemic or structurally engendered "inhumanities" on the one hand and the concrete, personal responsibility in real situations and in the case of overlaps and conflicts on the other hand. Both are considered to be particularly important in terms of concrete humanity. So, we always have to perform a difficult balancing act, especially when dealing with institutional and corporate responsibilities.

Here Are Some Summarizing Theses

20. It is important that emphasizing collective or corporate responsibility should not serve as a "shield" or maneuvering trick to *distract from individual personal* responsibility, thereby opening the door to personal irresponsible action—in the sense that we would, for example, claim that individuals are no longer personally responsible, but only the state, institution, group, or society at large. We

[15] Is anyone here to be held responsible in a tangible and controllable way? Developing an information ethics in this respect is a very urgent task for the near future; in fact, one does not see any possibility at all for the concrete shaping of an operationalizable ethics with regard to the worldwide information systems—except for the necessity of expanding the traditional concepts.

know the excuses of the "cogwheels," the excuses of the concentration camp henchmen for following emergency orders and the like.

21. It should be noted and emphasized that supra-individual responsibility does not become obsolete simply because certain individuals bear some level of (co-) responsibility. There are indeed collective and corporate responsibilities that cannot be reduced to the individual, although they are always connected to the personal in the sense: Even in view of this irreducibility, some form of personal co-responsibility is always activated in a specific case.
22. Wherever possible, responsibility should also always be understood as open for participation and open to the future (i.e., for the control of *future* actions, decisions, plans, risk apportionment) and cannot merely be reduced to assigning blame for past actions to individual scapegoats: Responsibility in systemic contexts and action and decision-making structures is always an essential part of the practice of joint or co-responsibility and responsibility for the future. Individuals cannot be held *solely responsible* for what they have not caused on their own, nor for events for which they cannot be fully responsible. But as participants or members, they can bear co-responsibility—to the extent of their participation, power of influence, or participation in decision-making or the centrality of their position.
23. According to Jonas (1979, Engl. 1984), this responsibility for the future always includes not only the ethics of precaution and prevention, but also the *responsibility* for care—especially for those who are dependent on us, in accordance with the situation and social situation.
24. It is also particularly important to note that the attribution of individual, personal responsibility must always be seen or embedded from the perspective of concrete humanity and its dimensions. Albert Schweitzer's "ethics as concrete humanity" (cf. Lenk, 2000) is and remains a prototypical model for this.[16]
25. Thesis 5 is important, especially in view of the increasing predominance of associational and institutional powers and influences that threaten to displace the individual and his or her contributions and influences. This also applies within institutions, in technology and economy: in case of doubt, defer to concrete humanity!
26. Only concrete humanity can make the general idea of humanity tangible, make it operational, keep it bearable in the sense that the extant concrete responsibility is simultaneously appropriate to the situation, open to participation, and prospective.

In dubio pro humanitate concreta!
In case of doubt: defer to concrete humanity!

[16] Although Schweitzer wrongly devalues the collective responsibilities of "social ethics" and of organizations, institutions, and groups etc. as not actually ethical.

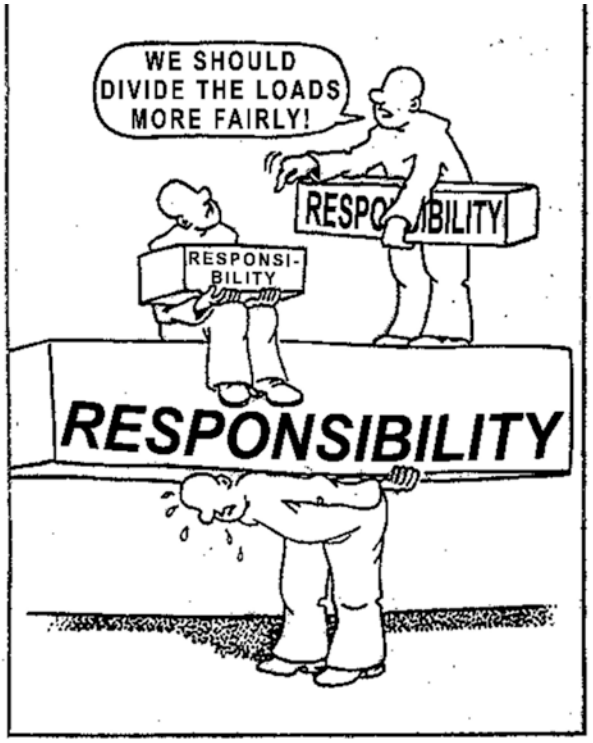

Fig. 2.1 "We should divide the burden more fairly." After the German version in Badische Neueste Nachrichten, Karlsruhe, (repr. in Lenk, 2019, p. 279, reproduced with permission)

Distribution of Responsibility(s)

How should responsibilities be divided in a fair and plausible way? I copied the following picture once from the *Badische Neueste Nachrichten* (Fig. 2.1):

The distribution of responsibility in this form may not be the (patent) solution to all problems, but a distribution problem will of course always arise—or often even several distribution problems. These are often quite difficult to treat. I would like to mention just a few theses on this subject:

27. It cannot be assumed that collective responsibility can always be reduced/reduced completely to the individual, personal responsibility of the actors or defined solely by them. This is ultimately easy(ier) to do, namely to divide or measure quantitatively, only in the case of compensation obligations.
28. It is necessary to develop an extension of responsibilities through operationally manageable, functioning models for the distribution of *co-responsibility* or co-responsibility.

By no means are mere appeals enough to avoid conflict situations or to avoid possible "social traps" that can arise (e.g., from the structure of the so-called "prisoner's dilemma"). There are contradictions that are, so to speak, embedded in the situation; for example, ecology (overgrazing of pastures in the Sahel already treated by Hardin in 1968) can be used to illustrate this very vividly. This means that you need for practical application more than analyses and appeals—yet indeed both are necessary. You have to develop operational access options—and this is at times cumbersome; but it is also difficult to carry out them in adequate detail. As a guideline, for example, one could often use a rule familiar from economics: Only as many laws, commandments, orders, and prohibitions as necessary—but as many incentives, personal initiatives, and personal responsibilities as possible.

A dilemma of responsibility exists, and often arises when committees make decisions, in so far as the anonymity or protection of committees can dilute certain decisions and the responsibility of the individual seems to disappear, so to speak. This is still the case today, even in Parliament, which is why there are sometimes personal or roll-call votes.[17]

On the Question of Responsibility, Especially in the Applied Natural Sciences

First of all, to get you in the mood, here is an example of the discussion of responsibility among some scientists.

It was 1984, i.e., still in the *pre*-Chernobyl era, when I wrote in our university magazine "Fridericiana" in an essay on "Responsibility and Technology" that the responsibility for major scientific and technological projects could no longer really be borne by individual persons: "An individual could only bear the responsibility for a major technological project pro forma, in form, publicly—politically, as it were. But what good is it if he (e.g., the manager of a nuclear power plant) resigns after an MCA (maximum credible accident)—after a major accident to be assumed? Mere formalistic assumption of responsibility no longer seems sufficient." I then received an angry letter from a physicist based at the Jülich nuclear research facility, from which I would like to quote: "What Professor Lenk says about the real aspects of responsibility, especially that of the technician, for example at the point where there is talk of an MCA (maximum credible accident) is, to put it mildly, the worst distortion of the facts." The MCA had only (?) as a "design-basis accident" binding reality for the technician. The responsibility of the technician for ensuring that such an

[17] Interestingly enough, this had even been observed in American expedition groups climbing Mount Everest, which were subjected accompanying to social-psychological research. It was found that the decisions that the groups each made were riskier than the decisions that individuals would make if they were solely responsible for them, although group decisions sometimes involved risking the life and death of the respective members. This is an interesting phenomenon called the "risky-shift" phenomenon (according to Stoner, 1968). This is found in many such or similar situation structures, quite apart from the usual problem of "dilution" of responsibilities found in committees.

incident is reliably controlled "cannot be eliminated by ignorance; it is codified in law and can be prosecuted." He also noted: "but it is about the factual sides of responsibility of the powerful of the word, e.g., for what they want to do, operate, suggest, or set in motion with the mere word MCA." The author of the letter also complains about the traditional academic treatment of "the ones of Professor Lenk's caliber" dealing with traditional ethics and says that "there are still considerable deficiencies to be remedied." He advises me "to deal less with the ethical problems of technology and more with the various techniques of responsibility, to deal with them effectively in journalistic terms, for example under topics like these: 'Responsibility and ignorance', 'Responsibility and modern politics', 'Responsibility of academic teachers of today'." The physicist is right with the latter advice. And I was glad to take it—indeed, I did so in rather many publications and practice-oriented seminars together with several colleagues from departments of technology. However, he did not understand the point of the argumentation at all. Perhaps he should not be reproached with the fact that he regarded the MCA, the maximum credible accident, merely as "design-basis accident," i.e., as not realistic, but only as a model fiction (it was not yet publicly known that a core meltdown had also previously occurred in Harrisburg)—and certainly not as realistic or realizable regarding the "super-accident," which goes beyond the *assumed* model *to be assumed.* Perhaps more importantly, political strategies of individual responsibility (the chairman of the Chernobyl nuclear power plant *was,* as is well known, dismissed) and legal codification are in fact no longer sufficient as instruments of regulation. The scapegoat search and perception is more like a ritual of displaying powerlessness. One (and *only* one) should be responsible, held accountable. Science and technology have apparently become too powerful to be adequately covered and even, in extreme cases, controlled by the traditional measures of political and legal regulations of purely personal responsibility—especially in the sense of reprehensibility (Bodenheimer, 1980; Ladd, 1990).[18] If the chairman of a nuclear power plant or the responsible minister has to resign (or—more realistically in Germany—sends his state secretary into early retirement with a not inconsiderable pension), then indeed this only actually shows the relative powerlessness of such regulations. I repeat: the problem of responsibility can no longer be solved in a merely political and formalistic way in view of the major projects of the great power science and technology and its societal impact and factual power of influence.

To whom are scientists responsible? To their individual conscience only? But isn't conscience rather a medium, a "voice" of self-attribution, of self-responsibility, in other words, an instance that estimates and measures responsibility, that applies a criterion that already presupposes itself? Is moral–practical reason this decisive instance, as it has always been seen in the tradition of philosophy, especially with Kant? Or the idea of human self-esteem, the "idea of humankind" or of society? Are we ethically responsible to humanity or society or the law? Well, all of that in a

[18] Rather, the (negative) formulation of the strategic responsibility for prevention and precaution according to H. Jonas (1979) seems to be fruitfully open to sharing responsibility and co-responsibility, without the overall responsibility or that of the individual participants dissolving.

sense, yes. But these are all abstract concepts, not living personal entities, not partners whom someone could hold directly responsible and accountable. Responsibility towards an abstract or an idea remains a metaphor, however effective it may or should be. Social controls or legal controls concretize this general social responsibility, but they are already decreasing in relation to direct personal ethical responsibility. In particular, it must be said that individual ethical responsibility is ultimately always directed at a *person*. Final responsibility is *personal* responsibility[19]—thus says the tradition. But, as we saw, that is not the only responsibility we have to deal with: Individual responsibility is important, but not enough. Ethical responsibility is more than the empirical voice of conscience. Societal bearers of responsibility are also very important and to be taken into consideration—and their social responsibility is to be somehow operationalized into the practice of technological control, planning, and leadership as well.

There is no doubt that both the ideas of social and personal responsibility are closely related to the idea of human dignity—the dignity of both the human society at large and that of persons responsible and the (human) addressees. It is part of human dignity, of the corresponding obligation and of being human, to assume and exercise responsibility, provided one is an acting and relatively effective free being. Freedom of action and responsibility are mutually dependent. The idea of human dignity encompasses that of respect for one's fellow human beings and for one's own person as well as for human groups and institutions, etc. That would certainly include the idea of existence and human(e) survival and the development of humanity, which was particularly emphasized by Jonas (1979/1984).

Furthermore, I think it is part of the idea of human dignity that we—as insightful beings who can at least partially recognize, decipher, and partially direct and control the natural (eco-)systems and phenomena—should preserve and take care of them respecting their own sort of "dignity." We can and should also take responsibility for other natural creatures and even for comprehensive natural systems (ecosystems). This responsibility grows with our insight and our ability to intervene, especially with our enormous destructive power—which in that regard is in danger of "running wild" in several ecological respects. We can and should, as insightful beings, think representatively for other beings, know ourselves responsible and co-responsible for them as well if they are dependent on us.

One may then ask how, in view of the diversity of the concepts of responsibility mentioned, it is possible to arrive at concrete, globally uniform decisions that are nevertheless appropriate in terms of problems and situations, in a humane or caretaking way. After all, our traditional intuition is that, ultimately, responsibility must somehow be indivisible, at least—but not only—as far as personal responsibility is concerned. Even community responsibility, in a certain sense, is, I would not say divisible in the sense of distributable or divisible, but rather *open to participation*, such as the responsibility of members of parliament. Such overriding responsibilities affect everyone almost alike and cannot be minimized by division. All that must not and should not—especially in the moral sphere, but also in parliament, for

[19] Again, we find ourselves being led back to Kant's approach of the ethics of the C*ategorical Imperative* ("*Act representatively!* ", i.e., "act in such a way that all should want to act in such a way").

example—be based on the socio-psychological principle that the more people work in a group and actually bear responsibility, the less the individual feels that they bear personal responsibility. So, unfortunately, there is a dilution effect, which has already been examined philosophically and analytically, without all these problems having been solved.

Natural scientists, especially physicists, usually have an easier time than social and human scientists because they do not experiment *directly* with people. However, they also often make it easier for themselves, sometimes too easy. Nobel physicist Rudolf Mößbauer answered the question of what he thought about the responsibility of the natural sciences:

> This is very much in evidence, especially in Germany. In the field of basic research, one has no responsibility at all. We try to understand how nature works. It is something different when you do applied physics. But even that is exaggerated excessively in this country. I'm thinking about reactor technology… You simply cannot ban science. And if we stop science here in Germany, it will continue somewhere else. In Germany, hostility towards science is steering the entire research landscape into a very critical situation.[20]

Von Klitzing, also a Nobel physicist, also said that "in the application of research results" the natural scientist would have a responsibility: "In basic research this is not the case, after all one cannot forbid research."[21] The question of external responsibility in basic research is, of course, a serious problem, which has a tradition especially in physics—and not only in applied physics. This has been well known since the Manhattan project, namely that of developing atomic bombs, and the problem has been much discussed. But science had lost "its innocence" much earlier (Herrmann, 1982). One would at least have to refer to the development of combat gases by Fritz Haber who, as is well known, planned and promoted the first German use of poisonous gases in World War I (contrary to existing co-responsibilities under the Hague Convention, to which Germany was already a signatory) and continued some relevant research even after the war (!), together with other well-known scientists: Otto Hahn was also in this group, as were Richard Willstätter, Hans Geiger, and also James Franck who later even drafted and presented the Bethe Franck Report *against* the use of the American atomic bomb on civilians.

Through all these projects and experiences, the *external* moral responsibility of scientists has of course become the subject of discussion in varying degrees of detail.[22] As already mentioned, even among scientists it is easy to confuse the *internal* and *external* question or form of responsibility. Ethics of science, or more precisely: general ethics or universal morals in the sciences or moral responsibility towards the potentially affected persons on the one hand and the guild *ethos*[23] of the

[20] See Lenk (2015, p. 337)

[21] loc. cit.

[22] It should not be denied that the majority of research in physics and chemistry at least does not show the extreme escalation of external responsibility, as discussed here using exceptional examples. The following—admittedly extreme—examples are discussed in order to raise the profile of the problem of external responsibility, which is rarely encountered in everyday research and may even be suggested. (cf. the examples of Fritz Haber's initiative in the gas attacks of the First World War and the mentioned topic of the development of atomic bombs).

[23] The "rules of conduct" for scientists, which Mohr (1979) established, are such *ethos rules*.

scientist on the other hand should not be confused, although they should/must always be combined in the practical conduct of science. But therein lies the very problem.

I do not want to discuss the internal responsibility in the ethos of science in more detail here, but I will examine in some detail the external problems of the responsibility of the scientist.

So scientists also bear external responsibility. We want to discuss this in relation to those possibly affected by the results, for example directly by the research process. As already indicated, scientists tend to retreat to the *ethos* and say that only the best possible, efficient, clean, truthful research and honest, fair treatment of rivals would be their only "real" responsibility. But of course, this can no longer be true when it comes to direct human experiments or field experiments in which people are directly affected. Nor can it be taken too lightly if and because the transition from basic research to applied research becomes fluid. Just think of today's genetic biology, where the two can no longer be separated in a real and meaningful way. At minimum, the separation in detail has become very difficult. Of course, Lübbe (1980) is right in a certain sense when he believes that the scientist is overburdened with the full responsibility and the imposition of the assessment of all "harmful side effects" of scientific and technical progress. "Only bottomless moralism," he says, whose "responsibility pathetic is only the complement of its practical impotence," can extend the responsibility of persons beyond their power to act. But in reality, this is no longer possible in the barely penetrable forest of possibly grossly ramified responsibilities. Humans have simply become too powerful with their instruments, their scientific technology, their major interventions in eco-systems[24] in order not to feel jointly responsible for the impacts on humans and for the overall context. In view of the existing dangers, however, it is not enough to take overstraining insights as a reason to sit back and relax. This applies in principle and on a case-by-case basis also to individual scientists at strategic points in the development, application, and implementation of experimental research projects. I believe that a much more differentiated approach is needed here, and that the political and ethical problems must be integrated—including legally!—to tackle them.

Even the ambivalence of the positive and negative, destructive usability of technical and applied-scientific results can no longer be resolved so smoothly and easily by a Gordian knot sword stroke, in that or rather by the simply irresponsible basic research and the applied research for which common responsibility is to be taken. Often, neither could be completely separated from each other. All this has become much more difficult today. Not *feeling* responsible easily turns into irresponsibility. And if—as is our intuition—responsibility grows with power and knowledge, then the co-responsibility *of the* human being in general and of the powerful and knowing individual increases accordingly with both.

[24] Most of which have already become "artificial," "technogenic" small worlds with but residual nature.

So what is the external responsibility of the scientists or the researcher? The problem was made particularly clear again by Einstein, especially in his letter (actually written by Szilard) to President Roosevelt, in which, on the advice of Szilard and Wigner, Einstein recommended with a "heavy heart" the development of the American atomic bomb. Or later, after the bombs were dropped on Hiroshima and Nagasaki by the Atomic Scientists of Chicago and by the Society for Social Responsibility in Science, which was founded in 1949 together with Einstein and Paschkis.

The German branch of the Society for Social Responsibility in Science was founded only much later, in 1965. For the Federal Republic of Germany, however, one should also think of the call to action by the "Göttingen Eighteen" group of nuclear physicists, which ""was borne by the recognized practical co-responsibility of the knowledgeable person in a strategic position. Indeed, it was politically effective against the potential nuclear armament of the German Armed Forces. Or we should think of the first Pugwash Conference on Science and World Affairs in 1957, whose co-founder Rotblat was awarded the Nobel Peace Prize in 1995. This primarily morally motivated commitment of the scientists was later institutionalized in the Association of German Scientists, but did not lead to a broad general ethical debate but rather to concrete criticism and project evaluations, sometimes with some political explosiveness.

The Nobel Prize winner Max Born, one of the Göttingen Eighteen,[25] was extremely pessimistic:

> In our technical age, science has social, political and economic functions. No matter how far removed from technical application, one's own work is a link in the chain of actions and decisions that determine the fate of the human race. This aspect of science came to my attention in its full impact only after Hiroshima. But then it took on overwhelming significance and made me think about the changes that the natural sciences have caused in the affairs of people in my own time and where they might lead. Despite my love for scientific work, the result of my reflection was discouraging. It seems to me that nature's attempt to produce a thinking being on this Earth has failed. The reason for this is not only the considerable and even growing probability that a war with nuclear weapons could break out and destroy all life on Earth. Even if the catastrophe can be avoided, I dare to see only a gloomy future for humanity (1965, printed 1969, translated).

Born believes that the real disease of our technical age is the "collapse of all ethical principles." All attempts to adapt our ethical code to our situation in the technical age have failed. In my opinion, however, we cannot speak of such a "collapse" of *all* ethical principles; Rather, relative ineffectiveness, especially in the international arena and with regard to the technical possibilities of impact. Why is that so? How can new ethical orientations be gained that are appropriate for our systems-technological world of today? One thing is clear: we cannot afford, now or in the future, to neglect the urgent ethical problems of science, especially applied science and also technology.

[25] In April 1957, a group of 18 scientists published the Göttingen Declaration, which expressly opposed plans for nuclear armament in the Federal Republic of Germany. (see also Mieg, in this volume, Chap. 3).

In experiments with humans, so-called human experiments, people are directly involved in the scientific process during the research process, become, so to speak, objects of research: human guinea pigs—sometimes against their will and knowledge. The external responsibility is also particularly clear in so-called "field research" and applied research. However, it is not limited to this area. Opinions on this external responsibility are still very far apart. It has been said, for example, by the biochemist Ernest Chain (1970), that science as a descriptive study of the laws of nature has no ethical or moral quality, but is instead ethically neutral, and therefore, according to Chain, the scientist cannot be responsible for *any* harmful effects of his inventions—but, if anyone, then *society* is responsible. To society, of course, every scientist is obliged as *a citizen*. In particular, the scientist would not be—according to Chain—responsible for the application by others of a fundamental law which they had discovered and of whose applicability they could not even suspect at the beginning of their project. To hold them responsible for their discovery is tantamount to demanding that they correctly anticipate the outcome of their investigation before it has begun. The decision to pursue a particular application of scientific knowledge goes—and this is correct—far beyond the descriptive knowledge. It would therefore be pointless to ascribe to the scientist a responsibility for the application of their discovery in ways that were not decided by them self. The politician or decision-maker *alone* would have to take this on as *their* responsibility. Chain even goes so far as to say that scientists and technicians engaged in military research into the development of new weapons, whether ballistic or biological, have no responsibility for the terrible destructive effects of the weapons they develop. On the other hand, it has been emphasized, e.g., by Belsey (1978/1979), that, although at first glance freedom of research seems to be a general principle, there are nevertheless restrictions and special responsibilities in view of dangerous research areas, which include, for example, special risks for humanity: especially if the scientist them self has good reasons to believe that their discovery can be used by a political decision-making body in a way that is harmful to humanity, and that, for example, a government would probably use this development in such an abusive manner. In this case the scientist should not put this discovery in the hands of the government. Then, the scientist cannot (and this will probably be particularly explosive in the field of biotechnology and genetic engineering) simply wash their hands clean in public when discovering something that could be disastrous for mankind. Of course, one cannot demand that the scientist be able to correctly predict the outcome of research before it begins, but one can demand that (s)he would and can estimate probable disastrous results in some high-risk areas of research and should evaluate them in the overall framework and make a balanced assessment. But this is part of his/her normal human responsibility: Belsey says that there is no need for special morals in the ethics of science, but yet the scientists and technicians who apply them are occasionally at strategic junctures of the decision, which bring extra-technical and overarching connections into play and demand that the possible consequences of the decision be considered, even if is it only possible to obtain a partial overview of these consequences in advance.

The responsibility of the scientist is limited to the support of interdisciplinary cooperation and the timely and comprehensible information about scientific discoveries and about new technical possibilities and their problems. That also refers to the participation in pilot test projects. To wit, a university colleague postulated—without much irony—an appeal to the humanities to at last now take as their duty to "make *their* moon landing" ("we have done ours!") and to "solve"(!) convincingly the ethical problems of the applied sciences. A "solution" then to be adopted by the natural scientists and technologists. An all too easy piece of advice to shuffle off (thinking and realizing) one's own responsibility for one's professional activities.

Karl R. Popper said that "*only natural scientists*" could, for example, foresee the danger of population growth or estimate the increasing consumption of petroleum products or the risks of nuclear energy used for peaceful purposes—as if these were merely *scientific* problems. Only the scientists, he says, could assess the concomitants and consequences of their own achievements. Solely because of this they would bear greater responsibility than others. Popper explicitly states that the accessibility of new knowledge creates new obligations. However, this is part of the special responsibility of the scientist within the framework of his or her *role obligation*. "Everyone has a special responsibility where (s)he has either special power or special knowledge." Popper would like to activate responsibility and its awareness by introducing a "promise" for students of applied natural sciences, to be oriented on the Hippocratic Oath of the medical profession (according to Weltfish, 1945). On the other hand, as previously mentioned, Lübbe (1980) judged that the scientist would be hopelessly overburdened with the assessment of and responsibility for the harmful side effects of scientific and technical progress. In view of the unforeseeable consequences of the extended scientific and technical possibilities for action and widespread outcomes, the concept of responsibility is therefore notoriously overstretched. Scientists and technicians *could* not bear the responsibility at all, because these decisions were *politically* responsible at the level of our public civic culture. It is probably not a question of assigning responsibility to one individual alone, but of (bearing) *co-responsibility*, of sharing responsibility. In this respect, are scientists to be absolved of any responsibility, given their particular individual position and also that within the system?"

Is not much to be expected from scientists for the socio-political and social aspects of future planning, and especially with regard to their lack of willingness to take responsibility, as some critics of society suspected? Did they even, as one critic wrote, "deliberately mislead" the population during the critical period of Chernobyl, and in some cases even "lied through their teeth" by providing falsely reassuring explanations? Could they (not) have overlooked the dangerous situation at all—in the double meaning of this expression? The physicist Wolf Häfele even saw Chernobyl not as a physical, but "*only*"(!) as a "semantic catastrophe."[26] How can he even maintain this after 10,000 deaths (after 10 years) and much larger numbers

[26] Lecture by Wolf Häfele on "Ausstieg aus der Kernenergie - wohin?" (Phasing out nuclear energy - where to?) at the University of Karlsruhe (winter semester 1986/87), as part of the introductory 'general studies' program.

of children who have died or grown up damaged by radiation? Not to mention the various forms of environmental contamination.[27]

In fact, Werner Heisenberg and Carl Friedrich von Weizsäcker had already discussed this issue following the report on the dropping of the Hiroshima bomb and had demanded that the individual scientists involved in research and development should take careful and conscientious account of the wider context. Weizsäcker, for example, said at the time that the American nuclear physicists had not made enough effort to gain political influence before the bomb was dropped; they had—as if they had great decision-making powers!—given the decision on the use of the atomic bomb out of their hands too early, especially since only scientists were capable, he thought, much like Popper later, of thinking objectively and dispassionately and, most importantly, in big picture terms. This optimism about the power of judgement—the better and special judgement of scientists—probably no longer seems generally justifiable today. Nevertheless, as already mentioned, it is precisely scientific associations such as the *Atomic Scientists of Chicago* (ASC) that have made a very responsible effort to address the moral problems of the accountability of research and its consequences. But unfortunately to no avail.

Applied scientific and technical developments, for example the development of the combustion engine or the production of dynamite or nuclear energy, of course, usually have the ambivalence of a positive and a destructive usability for society or mankind (now one talks of "dual use" technologies). Moreover, especially in areas such as genetic engineering and genetic biology (where basic research and the further development of technology are particularly closely intertwined and, as mentioned, merge seamlessly), basic research and technical development can no longer be separated as smoothly and easily as the idealized distinction between the "discoverer" and the "inventor" assumes.

Edward Teller, at any rate, was later aware of this role; only that he always withdrew into the role of the neutral expert who was fascinated by such a technically "sweet" project, as Robert Oppenheimer, the so-called father of the atomic bomb in the Manhattan Engineer District Project, had put it. It seems to me that many such statements are still too bound to the traditional individualistic concept of sole individual responsibility for the cause.

From the point of view of the aforementioned *extended* responsibility of man according to Hans Jonas (1979) and in the light of the above-mentioned divisibility of co-responsibility, one could speak in a more differentiated way of co-responsibility without attributing to the scientists and especially to the individual researcher a total sole responsibility. The extended responsibility and the implied openness and possibility of participation in view of the Faustian Pact for scientific and technological progress, which was once entered into and is no longer easy to revoke, is indeed more important than a retroactive individual moral responsibility for the sole cause of basic research projects, which can hardly ever be ascribed. It is important to make

[27] The same applies to the nuclear catastrophe at Kyschtym (Mayak) in 1957, which only became more precisely known after the fall of communism, and which released about 20 times as much radioactivity as in Chernobyl!

scientists, especially younger ones and students, aware of such extended and shared responsibility.

I would like to round off what has been said with the demands of a late university colleague, a physicist who was also President of the European Physics Society: In 1995, solid state physicist Werner Buckel had said in a lecture on the occasion of the 50th anniversary of the first experimental atomic bomb explosion at Trinity Site in New Mexico that[28] "in view of the many risks that can arise from scientific results"—nuclear research being only one example—it can no longer be said that: "The scientist provides only new insights. What is done with it is not his concern." "This line of argumentation," said Buckel, "must finally come to an end." This assertion is "not tenable and it is dishonest," if only because all scientists are very willing to take responsibility for positive developments from their results. But: "One cannot know what one will find. So, apart from a few examples, forbidding and demonizing scientific research cannot be the means to save humanity from perhaps bad developments. All research would then have to be stopped. Nobody can seriously want this, because it would deprive humanity of any chance of solving emerging problems."

"It is my firm conviction," continued Buckel, "that there is only one path that we should consciously take: We must try to achieve a responsible approach to the results of science. The scientists have a major task in this respect. They are in a better position than anyone else to foresee the consequences of their research results. They have to face this task and they have to say relentlessly what they can foresee as a possibility." Elsewhere in the same paper, he noted that the "attempts" to make completely irresponsible research in "high-risk areas" understandable to the "educated layman" "often have the character of defensive speeches": "One wants to convince the listener of something and to do so one chooses suitable arguments, which are certainly all correct, but not the full truth. The public is very sensitive to this." (I remember the word of a former German Chancellor who once drove into a journalist's parade: "That may be true, but it is not the truth").

"What we need," says Buckel, "are scientists who can point out all as yet conceivable[29] consequences, regardless of whether or not this suits the donor or any strong interest groups. He then also pays tribute to the Göttingen Declaration of the eighteen German nuclear scientists of 1957,[30] and believes that the refusal to cooperate in equipping the Bundeswehr with nuclear weapons was "responsible action in the best sense". He concludes with a few noteworthy demands:

1. "Scientists must not be bought. They may not make their scientific statements for or against any interest groups and possibly receive a particularly high fee for doing so." A high-ranking politician, reported Buckel, had once said to him publicly: "It's clear: I get a positive report for everything. The only question is how

[28] This event was held on 15 July 1995 under the title "Science in Responsibility" on the occasion of the 50th anniversary of the first nuclear test explosion (on 15 July 1945) by the German Physical Society, the Association of German Scientists, the Natural Scientists' Initiative "Verantwortung für den Frieden" (Responsibility for Peace) and the Göttingen Scientists' Association.

[29] "*All* conceivable"? This is an unfulfillable demand.

[30] See footnote 24.

much I'm willing to pay." Buckel's comment: "This is a scathing judgement on the morals of some scientists." (Just the *scientist*? I don't think so…)
2. "Scientists should strive to anticipate the (possible) consequences of their work (if possible). This takes effort because you have to obtain knowledge outside of your field."
3. "Scientists should relentlessly disclose what negative consequences their results can have"—in addition to the positive ones. "This would enable us to identify and avoid these consequences at an early stage. Research should not be "forbidden," but "learn to master its results. Research is crucial to solving our future problems."
4. "This behavior of scientists requires a certain change in the consciousness of our society. It must be recognized as a value in society if scientists behave responsibly by identifying potential risks at an early stage." (Wishful thinking?)
5. He then demands that when scientists speak as such, they should "put aside their personal opinions." But as citizens, they could have an opinion," they should not only "be allowed" to have one, but also "should have" one—an evaluative opinion, which just "does not need to be scientifically founded," cannot be scientific. I think a little further reaching: that scientists should certainly also express their personal opinions in the context of the debate on applications of research and the public discussion of science, but these personal opinions should be *labelled* as such.

Do Ethics Committees and a Scientific Oath Solve the Moral Problems?

One has often referred in particular to scientific ethics committees, which should be used not only in medicine but for *all* sciences. It seems doubtful to me, however, whether a permanent ethics committee—which would be concerned with the investigation and assessment of the ethical, social, and legal implications of basic research, and with progress not only in biomedical research, but in technology and in science in general—would be the appropriate institution to steer science, even if this committee were interdisciplinary and broadly based. Obermeier (1979), who suggested this, said that it was long overdue to regulate science before the permanent innovations and progress overwhelmed us. However, this would probably also assume an unrealistic predictability of scientific discoveries and their consequences. The super-experts, the super commission, would be institutionalized in this way. But they do not exist, cannot exist. It would indeed be absolutely overstretched. Even though ethics committees may be useful in biomedical and pharmacological research as well as in all human experiments for control purposes (because here

people are directly and assessably subjected to the risk of the quite precisely known or, if possible, specified experiment),[31] a comprehensive commission is likely to find itself just as overwhelmed with the task of dealing with all the overarching problems of basic research as the individual scientist.

There is also useful commission work on individual questions, on concrete data definitions, which is undoubtedly very important and detailed. One thinks, for example, of the German Technical Instructions on Air Quality Control (Technische Anleitung zur Reinhaltung der Luft), which is also the result of careful commission work. In decision-making commissions of this kind, the scientists also assume quasi-legislative functions that fill out the framework guidelines of the laws, and this seems to be a very important transfer of overall responsibility today.

Some people, such as the retired biologist Hans Mohr, are apparently of the opinion that, ethically speaking, all this does not achieve anything (Mohr, 1979). The ethical commission solution could not work because science can only be morally judged and actually hardly ever be morally regulated in a way that is not influenced by political and social factors. Only the "ethos of science" functions for regulation, not the ethics of science. Otherwise, Mohr wrote by the end of the 1970s, no ethical uniformity among scientists could be achieved, as in life in general, nor could any "oath" be used to resolve honest differences of opinion and the legitimate pluralism of the scientific community on political issues. Politically, humanity is not a unity and cannot be brought to such a unity. But ethics is not only politics; and I do not believe that as an ethicist of science like Mohr has done his duty here. I think that he jumped to the extreme here, threw in the towel too quickly. In fact, humanity *must* come to a minimal consensus on survival, this must be a demand, a postulate of ethics: This is the only way to avoid a world catastrophe. It *must be* avoided. But even a "*Fiat moralitas, pereat mundus*" (morality must happen, even if the world may end) must not be a maxim. Incidentally, there are also certain fundamental convictions about the value of human life and its worthiness of preservation which are common to all cultures and societies and on which one can build.

[31] The convening of ethics commissions for the preliminary examination of all human experiments that may involve risks of harm is undoubtedly good, but practice is still controversial: some authors doubt the effectiveness and controllability of the commission; some fear the bureaucratic restrictions and requirements for research. A legal—at least something resembling "professional ethics"—regulation should also ensure the independence of the control; that seems indispensable and is widely supported, but the materialization of the well-taken idea was all too often given up or faltered due to increased bureaucratic cumbersomeness of the application, to industrial or political interests, checks and control procedures. For ethical reasons, however, such restrictions should be accepted for the sake of the people and ecosystems concerned.

The Hippocratic Oath is good as an idea, of course, but remains problematic because it has low effective-ness, (too) low controllability and enforceability.[32] It is good as an idea, but has a low effectiveness, (too) low controllability and enforceability. It does not take enough real political, practical action. It is at best ideal-typical. The idea of the Hippocratic Oath among scientists is not so absurd in human experiments and in research directly related to the experimental process. For the application of the results of completed research, other regulations should probably be used—strictly understood, more similar to the Hippocratic Oath (which is also primarily about the application of scientific knowledge or medical art in therapy). A certain co-responsibility of the scientist providing the procedures can be given on a case-by-case basis (particularly evident in the negative case: the scientific developer of napalm, Fieser, admittedly rejected any ethical co-responsibility just like Teller, the so-called "father of the hydrogen bomb"!). As said, the crux of the oath of science, which is analogous to the Hippocratic Oath of science, remains the low effectiveness, controllability, and enforceability. It is precisely an idea that is too general and abstract, too readily acceptable, and not concrete enough to be able to solve the ethical problems of research realistically.

The problem of ethical and legal control cannot be solved by the oath alone, especially since the career system of scientists has, in a certain sense, a built-in tendency in the opposite direction, namely incentives to violate ethical standards. A study of American medical researchers by Bernhard Barber (1976) showed that ambitious, upwards striving, and less successful scientists in particular tend to push

[32] Probably one of the first examples of proposed oath formulations for natural scientists came from Gene Weltfish (1945): "I pledge that I will use my knowledge for the good of humanity and against the destructive forces of the world and the ruthless intent of men; and that I will work together with my fellow scientists of whatever nation, creed or color, for these, our common ends." Newer versions include the following : Buenos Aires 1988 (International Symposium on Scientists, Peace and Disarmament): "Aware that, in the absence of ethical control, science and its products can damage society and its future, I pledge that my own scientific capabilities will never be employed merely for renumeration or prestige or an instruction of employers or political leaders only, but solely on my personal belief and social responsibility—based on my own knowledge and on consideration of the circumstances and possible consequences of my work—that the scientific or technical research I undertake is truly in the best interest of society and peace." Authors of the Institute for Social Inventions (n.d.; cf. also Lenk, 1991) in London proposed a Hippocratic Oath for Scientists, Engineers and Technologists: "I solemnly pledge myself to consecrate my life to the service of humanity; I will give to my teachers the respect and gratitude which is their due; I will practise my profession with conscience and dignity; The well-being of humanity will be my first consideration; I will maintain, by all the means in my power, the honour and the noble traditions of my profession; I will look on my colleagues as on my own family; I will not permit considerations of religion, nationality, race, politics or social standing to intervene between my work and my duty to humanity; I will maintain the utmost respect for human life from its beginning even under threat; I will abstain from whatever is deleterious and mischievous; I will not use my knowledge contrary to the laws of humanity; I make these promises solemnly, freely and upon my honor." In 1999, the Nobel Peace Prize winner (together with the Pugwash Conferences he chaired) Joseph Rotblat proposed the following version: "I promise to work for a better world, where science and technology are used in socially responsible ways. I will not use my education for any purpose intended to harm human beings or the environment. Throughout my career, I will consider the ethical implications of my work before I take action. While the demands placed upon me may be great, I sign this declaration because I recognize that individual responsibility is the first step on the path to peace" (Rotblat, 1999).

ethical considerations completely aside in human experimentation and, in the interest of their own scientific careers, to produce exciting or sensational experiments and results quite quickly. This is of course a dangerous development. In a certain sense, ethics committees can certainly introduce a code of ethics here, a limitation on ethically unacceptable human experiments that has indeed occurred. In any case, mere career considerations should not exacerbate the dilemma of human experiments. Checks do indeed appear necessary. However, making them effective with minimal impediment to research is also a valuable research postulate—and presents a very difficult ethical demarcation problem.

One example is the (quasi-sporting) the competition to fully sequence the human genome. Such conflicts are built into any dynamic research in particular, and often seem to be an indispensable motivational force. Ideally, such motivations should not be at the expense of human test subjects, especially not the individuals involved in invasive physical or psychological experiments. On the subjects' side, ethics is certainly first and foremost the ethics of the individual, usually aimed at ensuring their overriding personal integrity.

In the interests of many of those affected, however, science should not be unnecessarily hindered or prevented. So far, there are no patent remedies for all-round solutions to such conflicts. One must do everything possible to raise the awareness of conflict and support scientists, such that they are not compelled to decide unilaterally in the case of application, meaning not to blindly follow one's own career interests and not to suppress ethical considerations.[33]

Co-responsibility Without Sole Responsibility

The responsibility of the researcher in science and technology is indeed a special case of role-specific and moral responsibility in a strategic position. Consideration of the aforementioned fiduciary responsibility for prevention and protection is required wherever harmful effects can be estimated and averted, e.g., in directly application-oriented scientific and technical projects. A personal co-responsibility may be given on a case-by-case basis, but a general strict or even sole causal responsibility of scientists and technicians does not exist in any case, especially in basic research, in view of the ambivalence and collective origin of research results. This means in fact: *co-responsibility to be* differentiated and concretized in more detail *without sole personal responsibility*. We must find such a middle solution. All the more important is the preventive responsibility, the responsibility to prevent destruction and permanent damage in advance. In view of the dynamics of development

[33] Unethical research corresponds roughly to covert foul play or doping in elite sport. Not only is it unfair, as in sports competition, to gain and use an advantage for oneself through some kind of rule violation, but it would also be unfair and unethical to damage or harm others: in sports, mostly one's opponents, or in research one's test subject or uninvolved but affected persons. Perhaps one should not be too "sports-like" with research in particular. But this remains an idle call in a time of intensified and still increasing competition for research results and positions—as well as for researchers' reputation and qualification.

and the difficulties of orientation and evaluation in this entire problem area, it seems to me that the only realistic way to adequately turn to the ethical challenges of the future is to promote moral awareness in questions of the ethics of science among all scientists, if possible, and especially among prospective young scientists, and to discuss the interrelationships related to individual research projects, especially on the basis of concrete case studies.

A change has taken place in medical research, especially of course in the ethical and legal debates on genetic engineering and more recently in stem cell research. In other applied sciences they lag even further behind. Ethics should therefore not only be demanded and promoted as a school subject, but should also be developed as a scientific–ethical awareness subject for moral conscience training in the field of research, especially in the education geared towards it. There is moral importance in appropriately training the consciousness of prospective scientists and technicians. Only if this (moral awareness) is widely stimulated and practiced will it be possible to recognize more precisely the extended co-responsibility, the division of responsibility without deduction of responsibility and without attributing sole responsibility to the scientists themselves, and will it be possible for them to handle it.

Sensitive Co-responsibility: Comments on "Scientific Freedom and Scientific Responsibility"

My following considerations responded to the theses on responsibility in science conveyed in the publication "Scientific Freedom and Scientific Responsibility: Recommendations for Handling Security-Relevant Research" published by the German Research Foundation (DFG) in cooperation with Leopoldina, the German National Academy of Sciences (DFG & Leopoldina, 2014).

Problems of responsibility in the sciences become all the more urgent the more that scientific knowledge, skills, and technical as well as political or institutional power grow, and the more the technical world is shaped by them. Power, skill, *and* knowledge do hold someone responsible. In the systems-connected world, the allocation of responsibility to individuals alone is no longer sufficient.

Total neutrality of the scientist and science as an institution/professional association is just as unrealistic as a sole responsibility of the individual scientist and technical researcher would be. Their informed and sensitive *co-responsibility* is necessary, especially in security-related research. *System responsibilities* are easy to demand, but very difficult to deal with in practical–operational terms.

Analytically one should, as far as possible, continue to distinguish between the model poles of "pure basic research" and "technical application," between "discovery" and "development." However, reality today is mostly concretized in intermediate types, mixed types, e.g., in application-oriented basic research or fundamental ("knowledge-oriented") purpose-oriented research or in the (e.g., information and biotechnological) development of purpose-oriented methods (basic) research.

Participation models should be developed in order to make more comprehensible, operational, and tangible not only the *internal* responsibility of the guilds ("the ethos of science") but also the *external* co-responsibility of scientists and technicians towards society and mankind. The idea of sharing responsibility according to centrality and influence via power, strategic position in research, and decision-making processes—and through knowledge in this regard—needs to be elaborated more precisely. Institutional procedural regulations for assessment and possible sanctions should be developed (protection of particularly morally acting experts, e.g., "*whistle blowers"*, awards, opportunities for discussion for training and orientation purposes, hearings, committees, etc.), without simply subjecting *everything* to legal regulation or an ethical paternalism of everything (e.g., through blanket "can" formulations, see below) and/or through bureaucratic supercommissions: Ethics goes beyond mere legal regulations. It is important, however, to involve the scientists themselves in the fundamental interdisciplinary discussion that goes beyond science itself (This took many decades, namely until the so-called *codes of ethics,* already in the USA, e.g., IEEE, APA, as well as ethics committees in German science, technology, medicine, etc.).

Different types and forms of responsibilities (see above) are to be distinguished as "analytically clean" models (as "ideal types"): They can usually overlap or conflict with each other. In order to clearly identify and prepare the resolution or mitigation of conflicts of responsibility, it is urgent to examine them more closely.

Priority rules of (un)responsibilities as orienting guidelines (e.g.: direct and moral responsibility takes precedence over indirect and role responsibility) are to be more precisely drafted, elaborated, and reviewed in (not only subject-related) expert groups of scientific and technical associations, also through public discussion, but including practice-oriented philosophical–ethical and social science analysis.

This, and also the consideration of the internationally quite differentiated debate (and the national preparatory work) is still somewhat lacking, especially since the new "Recommendations" of the DFG and the Leopoldina, as important as the (rather belated)start is.

A few more details on the "Recommendations" themselves: In these it is rightly emphasized that the specific "guild-like" internal responsibility—and also the universal moral (general–ethical) one—goes or "can" go beyond the purely legal "obligation." New considerations include the binding requirement of transparency (with justified exceptions), the emphasis on the "*dual-use*" problem of protecting constitutional "goods" and "values", the justified weighing and monitoring of risks of damage and a "should be" obligation of prior and accompanying consideration of problems, of consequences, implementation, controllability, and further publication, as well as an institutional obligation to raise legal and ethical awareness of abuses, including the problems of whistle-blowers and their protection.

It must be criticized, however, that apart from the twice mentioned (but not specified in any way) "special responsibility" of the scientist and that the "primary goal" is "to carry out and communicate research in a responsible way", no differentiating statements at all can be found about the different types and kinds of responsibility of the scientist and the scientific institutions: Vague and meaningless or ultimately

non-binding formulations such as constant "can" statements (instead of the normative "should" or equally rare, but here too sometimes misleading, "must" standards) are editorially objectionable. More importantly, no distinction whatsoever can be made between the very different types and nature of responsibilities (apart from personal, institutional, and legal), let alone certain rules or orienting guidelines for dealing with (completely unnamed, but nevertheless typical) *conflicts of responsibility*, for example in the sense of (ethically or constitutionally based) priority rules (existing analyses have simply not been taken note of). Despite the reference to "concrete measures," the latter are not mentioned (except for the reference to awareness training). However, it is stated that the "measures" (which are not at all specified in the recommendation) "must not be permitted to inappropriately hinder research and are subject to feasibility and proportionality." (what does this mean and who would decree that?).

All in all, these (without the participation of analytical–philosophical or ethical experts) are very amateurishly "hand-knitted" "recommendations" without a truly theoretical–analytical clarification and practically guiding function.

Theses on Responsibility in Science

Finally, I would like to mention fifteen theses on responsibility in science,[34] which of course still need to be explained and supplemented in detail:

1. Problems of responsibility become more urgent the more scientific knowledge and technical power grows and the more the technical world is shaped. Power *and* knowledge make someone (co-)responsible.
2. Total neutrality of the scientist and science as an institution/professional association is as unrealistic as a sole responsibility of the scientist and technician would be.
3. Analytically speaking one should, as far as possible, continue to distinguish between the model poles of "pure basic research" and "technical application," between "discovery" and "development." Otto Hahn could not be held responsible for the development of the atomic bomb, but Edward Teller was partly responsible for the H-bomb. However, reality today is mostly concretized in intermediate types, mixed types, e.g., in application-oriented basic research or basically purpose-oriented research or in the (e.g., information) technological developments of purpose-oriented methods (basic principles).
4. In some new fields of research—for example in scientific computer science and information technology, but especially in biotechnology, for example in genetic biology and genetic engineering—basic research and possible applications are so closely linked, even interwoven, that there is often no real separation between

[34] Based on old theses from 1996 to 1998, here in selection, edited and supplemented, presented with the comments from a colloquium at the Karlsruhe Institute of Technology, 2015.

experimental research, applied science and technology or scientific technology. Research and development results can sometimes lead almost immediately and very quickly to possible applications. The *explosiveness* of external responsibility problems in biomedical research, biotechnology, for example, is penetrating the sciences, and is intensifying the problem of responsibility even for the basic researcher.

5. Participation models must be developed in order to make the external co-responsibility of scientists and technicians towards society and "humanity" and to make group and co-responsibility more comprehensible, operational, and tangible. The idea of sharing responsibility according to centrality and influence through power and knowledge must be elaborated. Institutional procedural regulations for assessment and possible sanctions should be developed (protection of particularly morally acting experts, awards, discussion opportunities for training and orientation purposes, hearings, etc.), without simply subjecting everything to legal regulation or the ethicization of everything and everyone by bureaucratic supercommissions: Morality goes beyond legal regulations (Germans, in particular, like to suppress this insight). It is important to involve scientists themselves in the interdisciplinary discussion which goes beyond science itself.
6. Different kinds and types of responsibilities must be distinguished analytically (see above). They can and do overlap each other in social reality, or more often, yes, typically conflict with each other. In order to clearly identify—and prepare the solution to—conflicts of responsibility, they need to be examined more closely.
7. Practical relevance and empirical studies of observations and experiences as well as social-psychological, group-dynamic experiments should be initiated in a targeted manner and should take place in a problem-oriented manner, the results of which can be easily grasped.
8. Priority regulations (see above) of responsibilities (e.g., direct and moral responsibility takes precedence over indirect and role responsibility) are to be drafted and reviewed by means of possibly public discussion (e.g., also in and by commissions of inquiry) and academic or philosophical analysis.
9. In practical situations of conflicts of responsibility and conscience, the concrete human responsibility and conscience decision of the individual should be decisive, but this cannot be understood alone and isolated as the only foundation.
10. If conscience is indeed the conscious self-attribution, i.e., the explicit assumption and self-experience of responsibility, then a differentiated discussion and training of responsibility in the form of knowledge of different types of responsibility and the conflicts that frequently arise between them, as well as guidance and practical handling of the *combination of these different responsibilities in a concrete-human form, is at the same time also a differentiated cultivation of conscience.*
11. The social embedding and institutional design or standardization and orientation of the orientation of the variants of responsibility and conscience are necessary. Particularly in education and further training, there should also be training

in the culture of responsibility and conscience. The training of the individual conscience and especially the sensitive awareness and attention to different responsibilities and conflicts of responsibility is just as important in an increasingly complex society characterized by different loyalties as it is for the social subsystem of applied science or technology research.

12. Science and technology researchers and analytically trained moral philosophers with in-depth knowledge of scientific work, research, and innovation would have to cooperate and increasingly examine the finer practical structures of responsibility and relate their types, kinds and levels to each other and model them as realistically as possible.
13. In this way—and only in this way—can ethicists and moral philosophers also take on their own special *meta-responsibility of improving the conceptual methodology and social philosophy* with practical and truly beneficial prospects.
14. Practical and *concrete humanity* should always be a central guiding principle: *In dubio pro humanitate practica!*
15. As far as the ethical debate as a whole is concerned, in view of the challenges of applied science, research, and technology, we are unfortunately still almost at a beginning. It does not require a prophetic ability to put forward the thesis already mentioned in passing: We cannot afford today, and certainly not in the future, to neglect the urgent ethical problems of the applied sciences and in the world of technology (research) and business as we have done in the past.

We must differentiate the prophetic words of Marx: "The philosophers have only *interpreted* the world in different ways; but it is important to *change* it" in a *responsible and sustainable way*.[35]

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[35] Karl Marx's eleventh Feuerbach thesis (translated). The original sentence ends after "change it."

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