Contemporary Philosophies and Theories in Education 6

Sönke Ahrens

Experiment and Exploration: Forms of World-Disclosure

From Epistemology to Bildung

Translated by Andrew Rossiter

Springer

Experiment and Exploration: Forms of World-Disclosure

CONTEMPORARY PHILOSOPHIES AND THEORIES IN EDUCATION

Volume 6

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Introduction

An experiment is characterised by the fact that its results cannot be foreseen by the experimenter. This is also true of this work. It began with the attempt to redetermine the relationship between *Bildung*[1] and technology. At the end stands the distinction between two forms of world disclosure—experiment and exploration—and, with that, the founding structure of a general theory of world disclosure.

The work began with a distinction between learning and *Bildung* that, until now, has been predominantly used in the German speaking world. It was further motivated by the idea that, through the use of analogy, insight into the processes of *Bildung* and learning in the individual could be drawn from the observation of processes of scientific research. It ended with the understanding that processes of scientific insight and processes of individual insight are nothing other than different forms of the processes of world disclosure, and these can only be appropriately understood with the aid of a logic capable of addressing paradox, that can conceptually capture the eventful nature of these processes. Both insights have a crucial effect on the understanding of science as well as of the processes of learning and *Bildung*.

With reference to the individual—with a decisive shift in content—processes of learning can now be reconstructed as being explorative forms of world disclosure and processes of *Bildung* can be reconstructed as being experimental forms of world disclosure.

This work assumes that processes of world disclosure exist. Correspondingly, the claim is made that certain phenomenon can be understood using the concepts of experiment and exploration that have been previously inadequately described using other, similarly oriented concepts, or, indeed, as in the case of the experimental, certain phenomena can be understood that have even been regularly and systematically neglected. At the same time, this work is supported by nothing else than previously existing work and therefore also assumes that these forms of world

[1] Translator's note: Bildung—it is important for the English reader to realise that there is a distinction in German between Bildung and Erziehung (both translated as "education") which cannot be effectively rendered in English. "Cultivation" may be nearer in meaning to Bildung but suggests a nineteenth century discourse which is out of place here. For this reason, I will retain the commonplace non-translation of "education" as "Bildung" but would ask the reader to bear in mind that an act of cultivation beyond institutional forms is also implied here.

disclosure—both in the philosophy of science as well as in theories of learning and Bildung have always already been at stake.

One could speculate that, since the words exploration and experiment have already been previously used in the context of scientific research, this could be seen as an indication that we already try to intuitively distinguish that which can only later be systematically distinguished. Accordingly, it appears likely that some discussions of how science *in itself* proceeds stem from a confusion of these two forms of world disclosure.

On the part of educational science, together with the scepticism against a pedagogy exclusively focussed on learning there almost exists a consensus that "learning cannot be everything", and that therefore, there must be something else. According to the results and, at the same time, the basic assumptions of this work, the philosophy of science and theories of *Bildung* have both for a long time been dealing with the same subject without actually exchanging views about it in any kind of sustainable form.

Instead of having to seek out analogies, available elements of various theoretical traditions could be assembled together to create something that, in the beginning, was not foreseen. This has been prepared for on the part of the philosophy of science by the overcoming of the idea that something like a universal "logic of research" must exist and the turn to the empirical study of science associated with this. On the other hand, educational science had extended its focus to meta-individual structures through the comprehensive criticism of such positions that still placed the subject at the starting point of their deliberations as the metaphysical centre of knowledge.

At the same time, a systematic distinction comparable to that between *Bildung* and learning in the theory of *Bildung* was absent in theories of science and research, while the theory of *Bildung* still to a great extent remained arrested in a representational understanding of language. This allowed all the obscuring of all that which was just at that point moving toward the centre of interest in the philosophy of science: the things in their materiality, our bodily dealings with them and thus finally also the handling of technology. In the following, all this needs to be rendered plausible.

Although it must be emphasised that experiment and exploration do not stand in a hierarchical relationship to one another, the focus of this work is still on the experimental, which is usually, and falsely, subordinated to the explorative. For it can only ever be thought as an independent form of world disclosure when both are brought together: a systematic distinction between two complementary forms of world disclosure with the help of a paradox capable logic and a theoretical instrumentation that is able to push the decentralisation of the subject beyond the area of language into material and bodily areas.

The concept of *Bildung* that creates the starting point for the deliberations unfolded here has increasingly gained attention in the last years in the German speaking world, and has now begun to attract attention at the international level—together with the very German concept of *Bildung* itself—and is slowly finding a following in international debate. At the centre of this concept of *Bildung* stands

the distinction between two types of learning processes, whereby the concept "*Bildung*" is meant to characterise the "transformative" kind of learning as opposed to more traditional learning, and can thus also be termed the "transformative concept of *Bildung*". Helmet Peukert has expressed this distinction thus:

> We have become accustomed to distinguishing two ways of learning. The one kind is more of an additive learning, i.e. in the context of a given framework of orientation and behaviour we learn more and more details that, however, do not change this basic orientation and our behaviour and our understanding of ourselves, but rather confirm them. However, in addition to this, there is also the experience that, if we really allow it to, explodes our previous ways of dealing with reality and our understanding of ourselves that exceeds our capacity to accommodate. If we wish to really take on such experiences then this requires a transformation of the fundamental structures of our behaviour and our relation to ourselves. (Peukert 2003, p. 10)

The approaches gathered beneath the "transformative concept of *Bildung*" refer to an extremely heterogeneous choice of theories. For example, Winfried Matotzki suggests with Gregory Bateson that *Bildung* should be understood as a kind of elevated learning in which not only knowledge is accumulated but also transforms the foundations of learning according to Bateson's distinction of learning levels. Rainer Kokemohr has, in various places, and with reference to Jacques Lacan, undertaken the suggestion to "investigate *Bildung* […] as a process of adapting and converting those experiences that resist their subsumption under the figure of an existing model of world and self" (Kokemohr 2007, p. 21). Jenny Lüders (2007) has systematically shown in her thesis how the transformative can be thought with the help of Michel Foucault. Hans-Christoph Koller has made the (empirically supported) suggestion of understanding *Bildung* in the critically reflected tradition of Humboldt, with the help of Jean- François Lyotard's concept of dispute. He holds this to offer an "innovative process of emphasising new possibilities of language […] which holds open the dispute by helping to give expression to a previously unarticulatable 'something'" (Koller 1999, p. 150). This has itself become the starting point for further diverse empirical research.

Elsewhere, Koller, with reference to Kokemohr, summarises the distinction lying at basis of this thus:

> According to this way of understanding, processes of *Bildung* are differentiated from simple learning processes in that not only is the acquisition of new knowledge or new information (as in learning processes) at stake, but also a fundamental transformation of the ways and means in which such information or knowledge is processed. Processes of *Bildung*, in the sense of a transformation of a fundamental figure of the relations to world and self therefore present a kind of elevated process of learning in which the treatment of knowledge is also transformed in a fundamental manner. (Koller 2007, p. 50 f.)

Despite all the heterogeneity in the theories referred to, these approaches are bound together by the idea that processes of *Bildung* are distinguished in terms of quality from those that are commonly understood as learning processes.

In what respect this concept of "Bildung as transformation" corresponds to that which is described as "transformative learning" in the Anglo-Saxon world is an open question.[2] Accordingly it is both an interesting and open question as to what extent the criticisms of the basic assumptions of the "transformative concept of *Bildung*" depicted in this work also apply to the basic assumptions of "transformative learning".

Two aspects come to mind here: firstly, the attempt at raising the transformative to the level of a distinguishing criterion and, secondly, the way in which failure is conceptualised as a stimulus for these transformative processes. In contrast to this concept the following should present the advantages of a "general theory of world disclosure" based upon a paradox capable logic and which first makes the differentiation between experiment and exploration at all possible.

The structure of this work does not correspond to that of a classical introduction and this has, above all, two reasons: firstly, the argumentation indicates a more circular than linear structure which, in many places, requires both backward and forward referencing and so renders a graduated structure impossible. In a strong sense the results of this work form the starting point for its argumentation. That this does not result in a logically circular argument remains to be shown.

This more or less circular structure at the same time shares the characteristics of an experimental process which—and this is the second reason for the structure chosen here—it is here attempted to mirror in the form of this work. If this is more or less successful then the process depicted in the work, at the end of which the distinction between experiment and exploration stands, can itself be interpreted as an example of an experimental process of world disclosure. In the ideal case this work therefore serves not only as a depiction of its results but at the same time as a documentation of that which is depicted.

Those preferring a rapid entry into the work can jump to Chap. 2. Here you will find the most important theoretical building blocks, followed by the identified characteristics of experiment and exploration presented in the following Chap. 3. The fourth and final chapter is interesting as a starting point above all for those who wish to occupy themselves with the possible theoretical consequences of the theoretical approach presented here based on the example of a critical discussion of the concept of *Bildung*.

The structure in detail: in the *first chapter* the question of technology is discussed in a somewhat essayist fashion. This then leads to the question in what respect failure cannot be thought, as is often the case in both the theory of science as well as in the theory of *Bildung*, as being without precondition, but rather much more has as a precondition precisely that process that is triggered by it.

In Chap. 2 the concept of the experiment is introduced and delimited against conventional and misleading ways of understanding it. *Chapter 2* also serves to depict necessary and fundamental theoretical decisions. To these belongs the intensification of the central concepts of *Bildung*, learning, meaning and world until

[2] And was discussed this year at the conference "Transformative Learning meets Bildung", Freiburg, Germany, June 20th to 22nd, 2013.

their respective paradoxical forms can be clearly grasped theoretically. Crucial to this is the introduction of Spencer-Brown's logic, capable of addressing paradox, known above all for its application in system theory by Niklas Luhmann, but here used with the aid of Urs Stähelis deconstruction. This deconstructive interpretation allows the—admittedly very free—adoption of Jean-Luc Nancy's concept of the "shared world" [*geteilten Welt*], which here, as the paradoxical centre of every process of world disclosure, forms the hinge of the entire argumentation. Additionally, in Chap. 2, the methodological reasons will be given for the chosen approach.

In Chap. 3 twenty-one respective characteristics of experimental and explorative processes of world disclosure will be described and contrasted with one another, drawing on empirical laboratory studies, in order to then align them together with the distinction between *Bildung* and learning in Chap. 4. In contrast to what is normally done, the question regarding the procedure is not placed at the beginning, but rather at the centre of this work: in this way the form of presentation should also be kept as congruently as possible with the structure of the argumentation.

A translation always carries the temptation at one point or another of introducing new ideas, improving expressions, or altering the relation of different passages to one another according to the current focus of interests. It quickly became clear that—because of the structure of this work—a change in one place in the work almost always inevitably led to a change in another place, which once again would have led to another change, so that this book would have gradually become a new one. Not only would this have clashed with the sense of a translation, it would have also rendered even more difficult the dialogue between readers of the different editions which is being striven for here and is indeed only possible thanks to Andrew Rossiter's conscientious and careful translation.

Contents

Chapter 1
The Subversion of Technology

Don't know what I want,but I know how to get it.
—Sex Pistols, Anarchy in the UK

In the last few years many articles about technology have appeared in the human and social sciences, which begin with the observation that the number of technological things (technological forms such as methods based on interaction, such as coaching, testing, etc. belong to these) have increased, and that this is a remarkable characteristic of the present.[1] In this context, Hermann Bausinger reminds us that a large part of technology is thereby not even evident and remains mainly unconsidered in such analyses; he speaks of an "inconspicuous omnipresence of the technological" (Bausinger 1981).

Who would want to oppose that? Whoever speaks of a general increase in technology can expect less resistance than those who speak "of the world becoming technological" (Freyer 1960), of its "technologisation" (e.g. Joerges 1988) or the "technologisation of the everyday" (Irrgang 2002), or those even who describe modern culture as "technomorph", in which "(almost) nothing [remains] that is not technologically composed" (Böhme 2000, p. 164).

The reference to the size and increasing number of technologies mainly serves to emphasise that one's own work deals with technology, according to the motto: there is more and more technology, so works dealing with technology will also become more and more important. The object of interest is thereby emphasised as being especially important.

However, the consequences of this increase in technological things and procedures are often then barely investigated, and if so, then only as a question of *degree*. The latter is the case when the "increasing importance" of technology is

[1] It is at this point crucial not to discuss social and physical technologies separate from one another. Firstly, this is not, as should be shown in the following, persuasive for analytical reasons—the materialisation of social technologies is only one and not necessarily the decisive step in a chain of translational steps (see Sect. 3.8). Secondly, the political important shift associated with this would otherwise be missed if something gains a more assertive facticity in the form of physical technology.

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spoken of, and theoretical reflections are oriented *on the basis* of this (e.g. Euler 1999, p. 9), or when technology is subsumed as a generically neglected aspect under the more general problem of "processes of social transformation" (e.g. Ahrens 2007, p. 7).

A difference exists between the question as to the meaning technology has for society, the individual or particularly for the question of *Bildung* and the question as to the meaning of technological things and procedures *themselves*, i.e., their increasing quantity in its qualitative aspect.[2] The following should show that the first question cannot be adequately addressed before posing the latter. Insight into the qualitative consequences of the increase in technology leads to posing the question of the increasing importance of technology in a fundamentally different manner.

The following is thereby not initially concerned with the question as to how the lack of insight into its functioning, the forgetting of its initial abstraction and the failure to see the "non-technological essence" of technology favours the "unbridled" increase in technology, that accompanied both Husserl's, as well as Heidegger's, discussions of technology and which is still central today, in other forms, for example, in the work of Michel Serres and Bruno Latour. Here, the consequences that an increase in technological options brings for those conceptions put forward by theories of *Bildung* will be firstly dealt with.

The starting point, and exemplary object of the discussion, is thereby the "transformational concept of *Bildung*" which, in recent years, has increasingly become the focus of attention and the crystallisation point for different theoretical efforts at concretising the concept of *Bildung* and equipping it with a certain obligation beyond the boundaries of the philosophical discussion of *Bildung*.

As heterogeneous as the various theoretical elaborations of this "transformational concept of *Bildung*" might well appear—one element fundamentally occupies a central position: the thought that a process of *Bildung* is initiated by an experience of failure. If, in these conceptions, there exist situations relevant to *Bildung*, in which one does not progress using previously proven figures of world and self relations, but rather fails, then such situations are understood as problem situations, characterised by a lack of adequate solutions.

[2] Conversely, that the qualitative condition of technology has quantitative consequences would be a claim that is much too generally formulated for one to meaningfully investigate it. One would have to firstly sufficiently narrow down this claim, to e.g. technologies of production on the one hand, and economic growth on the other hand, in order to be able to make intelligible statements about the quantitative meaning of qualitative changes in technology. Here, Solow's thesis, its significance still not adequately reflected, that no other factor apart from technological progress has had a positive influence on economic growth in the long term. Solow first put this forward in 1956 in the article *A Contribution to the Theory of Economic Growth* in the *Quarterly Journal of Economics*, and a year later, 1957, empirically proved this using the example of the U.S.A. in the first half of the twentieth century in the article *Technical Change and the Aggregate Production Function* in the *Review of Economics and Statistics*. For a critique of Solow cf. Mankiw et al. 1992.

1.1 Failure as Precondition

> Ever tried, ever failed. No matter try again, fail again, / fail Samuel
> —better Beckett, Worstward Ho

Marotzki, with Bateson, explicitly places *Bildung* in the conceptual context of problem, failure and solution in his reformulation of the concept of *Bildung*: processes of *Bildung* would then come into play when conventional attempts at problem solving fail:

> Processes of *Bildung* present processes of learning as being of a higher level niveau. Because of the social complexity currently achieved they are increasingly needed. Their requirement is thus brought about by the historical situation. Argued conversely: *Bildung's* theoretical perspective thus unfolds a way of seeing a stock of social problems. Processes of *Bildung* are processes of the perception of social problems and attempts at problem solving. (Marotzki 1990, p. 52 f.; also cf. the almost identical Marotzki 1991, p. 123)

The role of failure in Marotzki becomes even clearer if one looks at the reasons he puts forward for emphasising the necessity of *Bildung*. These all refer to the failure of that which he characterises as "tradition based learning", with reference to a formulation of the Club of Rome: "currently" (1991) he sees the dominance of a "rationalistic paradigm" which is oriented according to the "mathematical-logical ideal of an information apparatus" (ibid., p. 121 f.).

For him, this is not simply a too narrow or plainly false theoretical view of learning, but rather the economy of this situation itself symptomatically indicates the situation of learning as well. This "tradition based learning", which is mirrored in the rationalistically reduced concept of learning is, according to Marotzki, itself in crisis. And this is a crisis which is drawn from the widening gap between the increasing complexity of contemporary society and the limitations in learning capacity.

Marotzki writes, with reference to Bateson, that "for him, the fundamental problem arises when socially complex problems are processed using, in the light of the respective conditions for learning, inflexible modes of learning" (ibid. p. 123 f.). In addition to this, Marotzki, with Peukert, thinks that many problems, the complexity of which cannot be understood in the "conventional" manner, quite possibly result from the failure of this "tradition based learning" in the face of new kinds of problems (ibid. p. 124).

The special importance of failure for the processes of *Bildung* has been recently re-emphasised under the aspect of the experience of otherness. The publishers of the conference proceedings on *Bildungsprozesse und Fremdheitserfahrung* [*Bildung's* Processes and the Experience of Otherness] see, apart from the efforts at producing an empirical accessibility in the conception of "*Bildung* as the transformation of fundamental figures of the relations to world and self", above all in the emphasis of an experience of crisis as an "occasion" for, or "challenge for the processes of *Bildung*" (Koller et al. 2007, p. 7) a difference to *Bildung's* theoretical tradition since Humboldt, in which they nonetheless situate this concept.[3]

[3] On situating the transformative concept of *Bildung* in the Humboldtian tradition cf. Koller's discussion of Humboldt's philosophy of language in Koller 1999, pp. 51–94.

In the light of the fundamental significance of failure for the processes of *Bildung* Lüders emphasises the necessity of taking into consideration the failure in the theoretical conceptualisation of *Bildung* in the widest sense, namely the theoretical conceptualisation and empirical attempts at the identification of the processes of *Bildung* themselves. She thus writes that one concern of her work is "not to bracket out the 'failure' of a conceptualisation of *Bildung*, but rather to reveal it to some extent." It becomes clear in this movement "that every 'failure' must itself be regarded as being a systematic—perhaps even a constitutive—moment of the event of *Bildung*" (Lüders 2007, p. 18).

Schäfer argues in a similar fashion, beginning with the encounter with the other, emphasising the impossibility of "fully subsuming the other through categorical appropriation" (Schäfer 2009, p. 188). He locates the cultivating [*bildende*] moment in the encounter with the other in the "necessity of the failure of one's own habits of perception of self and other" (ibid.), a failure that also concerns the conceptualisation of *Bildung* itself.

With Koller, failure as "occasion or motive for the search for the new" (Koller 2007, p. 56) pervades the discussions of various (science) theoreticians he has researched in terms of the applicability of their theories for a theory of *Bildung*. Thus Koller holds failure in both Popper's as well as Peirce's concepts in their respective theories of science as being relevant to a theory of *Bildung* because it is transferable.

A transfer is concerned insofar as processes of scientific insight and processes of *Bildung* are not identical.[4] Koller expresses this in speaking, with reference to the theory of science, of the "failure of a rule that was until now considered valid". At the same time he prefers, with reference to *Bildung*, the more open, less formalistic and emphasising of experience, but nonetheless failure oriented turn from the "crisis into which a person falls when he experiences something which his previous orientation is not sufficient to cope with" (ibid. p. 56).

The common ground that here legitimates a transference also lies in failure—on the one hand, in the failure of a "rule that was until now considered valid", and, on the other hand, in the failure of the "previous orientation" or "previous means and possibilities" (ibid., p. 50). If, continues Koller, one follows Derrida in his critique of conventional ideas of communication as a means of transferring meaning, the critique of a hermeneutical orientation towards the exposure of meaning and his radical account of the concept of writing, then failure must be fundamentally understood as the condition for the new: "from this perspective the emergence of new figures of the relations of self and world would take as their starting point the failure of the attempt at providing unifying self and world interpretations, and consist in the production of a manifold of differentiating, supplementing or contradicting

[4] Here too, it is assumed that they are not identical; which should neither mean that the processes of scientific knowledge cannot occur together with the processes of *Bildung*, or cannot stand in a conditional or other kind of relationship to one another, or generally have analogous structures at their disposal that would render a discussion of scientific processes interesting for a theory of *Bildung*. It is much more an indication that the depiction of these processes has to suffice their respectively different claims and necessarily emphasises different aspects—without these different focuses being necessarily identical with defining differences. For an expansion on this, cf. Sect. 2.1 as well as 4.1.

interpretations" (ibid., p. 65). The central importance of failure for the current conception of a transformative concept of *Bildung* should be clear.

If situations relevant to *Bildung* are those in which one does not progress with the aid of previously proven figures of world and self relations, but rather fails, then such situations will become—as has been mentioned—understood as problem situations characterised by a lack of adequate solutions. This concerns the description of a situation in which the present (the situation relevant to *Bildung*) is understood under the focus on the past (the failed world and self relations), while the future is determined as being undetermined (it remains not only undetermined, but is rather determined as being undetermined). In a certain way it concerns a present filled with the past without a graspable future. That must be so, for if the future were not undetermined then the radical new, which is characteristic of a successful process of *Bildung*, would also not be new, and one would, as a result, not be dealing with a process of *Bildung*.

Even if this is not wrong, this understanding articulated in this way is, in the face of the increase in technology, still inadequate and quite possibly no longer contemporary (see below). The problem that the following is concerned with does not consist of the question as to how the "emergence of the new in processes of *Bildung* can be more precisely described and explained" (Koller 2007, p. 50), and therefore does not reside in the theoretical challenge in the face of this necessary indeterminacy. It much more resides—as an equally theoretical as well as a practical problem of *Bildung*—to a certain extent in an over determined futural reference.[5]

What, however, is the problem with the relation of time in the determination of *Bildung* as a transformation of fundamental figures of world and self relations, as a result of the experience of failure in the light of a quantative increase in technological things and procedures? The problem is that our present present—in contrast to the past present—is much less filled with the past as it is much more filled with the future; it is, to a certain extent, pervaded by technology forming futural splinters which strike presently optional paths into indeterminacy, through which the future—no matter how the present might also appear to be suffused with problems—can no longer be determined as simply undetermined.[6]

1.2 Failure was Yesterday

The history of the future tells us: it is—and here one can draw upon presently secured, valid knowledge—initially the future itself that is increasingly suffused by technology.[7] Ever since the future even existed (it was, if one follows the futural historian

[5] Analogous to this from an anthropological view cf. Meyer-Drawes shifting of the Gehlen's determination of human being as a flawed being: "Considered more closely the human is not undetermined, but rather determined many times. It is in this sense not a flawed being that must compensate an instinctual deficit, but rather a being of excess, because it can deviate from its determination." (Meyer-Drawe 1995, p. 369).

[6] This is more or less Luhmann's view in the article *The Future Cannot Begin: Temporal Structures in Modern Society* from 1976.

[7] On this cf. Hölscher 1999 or also Berghoff 2000.

Hölscher, first invented in the familiar form known to us as an open horizon in the course of the seventeenth or eighteenth century), there has hardly ever been a more technology saturated future since the beginning of the nineteenth century (ibid.).

Hölscher is in this case precise: around 1890 a massive technologisation of the future took place, clearly recognisable in the rise of the science fiction novel. This process of technologisation reached its last peak in the sixties of the twentieth century and has, since then, somewhat ebbed. Dörpinghaus, who, in a short article about the relationship between *Bildung* and time, reflects on what consequences futural changes have for the idea of *Bildung*, sees—very similarly[8]—the crucial step in the history of the future as being the replacement of a course of time based on nature by one stamped technologically, symbolically illustrated by the deeply irritated feelings of time experienced by the first railway travellers (Dörpinghaus 2007, esp. p. 40).

This switch in the frame of orientation then contributed to what is today dealt with under the catchword "acceleration" (cf. Rosa 2008). The future is now no longer that which comes to one and that one can await like the second coming of Christ on the day of judgement, but is rather increasingly understood as a malleable time period on the horizon of a lifetime that appears to be ever shorter. Here, Dörpinghaus points out an extremely fundamental change in the structure of time, triggered by technology, in which technology serves to set the pace and is doubtless important for the conception of *Bildung*.

However, because Döpinghaus only refers to the structure of time in his subsequent work, without further mention of technology (it is as if technology had caused a change, which then exists independently of it, as if structures of time did not also have to be repeated again and again, renewed and confirmed, or as if this repetition and confirmation only takes place in a social space independent of all technology), in the following a more precise idea of the everyday meaning of technology for time as well as for problem-solution relations should be gained independently of his account. Dörpinghaus's theoretical thoughts on *Bildung* will initially be put aside. They will be taken up once again later.

Hölscher assumes that the meaning of technology for the future has today weakened (after the sixties in the twentieth century), which one can see in the fall in technology filled future utopias. In contrast, I will assume in the following that it is improbable that technology has lost its importance for the future (and the present), but rather that the impression of a weakened significance can be considered to be much more itself a result of the process of the technologisation of the future: utopian technologies have increasingly closed in on the present until today we in the present have always already stood with one foot in a technologically over-determined future (which renders the utopia less utopian but no less filled with technology): presently we deal with future technology (in the IT branch they are called beta-versions, in other areas, immature).

[8] Here too, even if with clearly another accentuation with reference to Hölscher. I thank the participants in the Philosophy of *Bildung* forum for pointing out this article from Dörpinghaus.

We increasingly use technologies that, on the one hand, are still being developed, and about which we, on the other hand—while we are already using them—reflect. We wonder how they will form our future, which has always already begun, while they already form our present and set the conditions under which we reflect our present and our future.[9] Today, hardly anyone is still so naive to believe that we *first re*flect, analyse problems, estimate and discuss consequences, *before* a technology is employed.

Technological solutions are always associated with rationality and pragmatism, but, on closer inspection, the way in which technology comes into the world indicates a deeply anarchic principle. This is not a new insight and has already been covered by, for example, Brecht in 1932. According to Brecht, this order is anarchic (an order which he freely associates with capitalism) insofar as many inventions are brought to the market that have not been ordered, that "still have to conquer their market and justify their existence" (Brecht 1976/1932, p. 127).

This is simply an initial indication of the problem of qualitative changes as a result of a quantitative increase in technological things and procedures. However, it is neither the whole picture, nor the crucial point. The crucial point is much rather another one: the increase in technological things and procedures presents an increase in options—and that is an increase in solution options which would be preferably deployed. This is what first renders an anarchic principle a problem, since this is rationally veiled by the impression of a choice of possibilities; technological solutions are characterised by their greater assertiveness and attractiveness in relation to other kinds of solution.

1.3 The Use of Technology

Technological solutions are often preferred because they are generally best at asserting themselves within social contexts, but especially in organisational ones. In this sense, Luhmann writes with reference to organisations, that it is normally those persons or aspects that are advantaged "which can most effectively operationalise their goals", and that means: present them in their technologised form (Luhmann and Schorr 1988, p. 42).

Why is it, one could ask, that the best or most persuasive solutions do not simply prevail? Luhmann's answer: technological solutions above all prevail because they avoid consensus.[10] Thus, they do not create one (as it sometimes appears to be

[9] No firm has better perfected this principle of the permanent imperfect as a business model than Google, and hardly any business model is so passionately praised as being ground breaking (e.g. from Jarvis 1999) as was earlier Toyota's *monozukuri* (on this cf. Liker 2003).

[10] On the other hand, technology and the technologisation of social contexts is that which can render them at all communicable in the first place—one only has to think of the political importance of statistics and data gathering technologies. So technology in no way spares consensus unconditionally—seen absolutely. This is missed by Luhmann just as it is in Habermas's confrontation between means-ends rational action and interaction (cf. Habermas 1969, p. 84).

ex post, when technologically caused problems push themselves to the fore) and technology does not normally solve conflicts (as it sometimes appears to be *ex post*, when the sounds of protest have died away), but much rather undermines consensus and the means of posing a problem.[11]

This is not to condemn in principle (on the contrary, as will be seen), not even from the perspective of the theory of communicative action, for some problems are solved with the aid of technology in a simple and effective manner, and can lead to the satisfying effect of releasing resources to solve more important problems.[12]

This can be demonstrated by an example close to everyday life: a couple that fights everyday about the washing-up have a problem with one another due to left-overs always drying on the plates. Were they to try to tackle the problem through the most thorough analysis of the situation possible, weighing up all the contributing factors, then they would quite possibly find themselves in the middle of a gender debate about their personal biographies sitting on their therapist's sofa. The complexity of social situations is, in principle, unlimited and can, with respect to both the settlement of the actual problem and with respect to possible solutions, in principle, be unfolded into eternity.[13]

By buying a dish-washer they *spare* themselves the effort of reaching a consensus in all these questions. The machine resolves neither the gender conflict nor does it clear up the problem with the in-laws, but it solves the problem of washing-up. It already becomes clear in this harmless example that with the appearance of the dish-washer the original problem (the lazy partner) is recursively rewritten in a manner compatible with the solution (dirty dishes being left to stand). The comforting effect of the future perfect is hereby not to be underestimated: with the purchase of a dish-washer we will have had a problem with washing-up.

However, in no case does the use of technology present itself as a solution in the sense of a well defined problem—its use is always accompanied by a redefinition of the problem—unless the problem is already so technologised that the translational steps towards using the technology[14] no longer themselves make a recognisable difference.[15]

This example is harmless. It becomes less harmless when one looks at situations where technological solutions are still preferred when the recursive use of a problem matching the solution does not lead to a rewriting in which interested parties are fairly compensated, but to a mere suspension of the original problem. An example of this would be the substitution of the problem of "bad teaching" with the problem of "insufficient variety of methods" or more generally: "how do I make my lesson compatible with evaluation?" when using corresponding evaluation technologies.

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[11] On *techné* and above all the indications of a concept of *techné* cf. Sect. 2.6.

[12] It is in this sense that Ortega y Gasset describes technology in his "*Thoughts on Technology*" as "an effort to save effort" (1983, p. 296).

[13] For an empirical proof of this cf. Kaufmann 1998. On conflicts achieving autonomy cf. Luhmann 1984, ch. 9 and Luhmann 1997a, p. 466 f.

[14] On the concept of translation in relation to technology see Sect. 3.13.

[15] This is carried out by Bruno Latour and Jim Johnson using the example of an automatic door-closer, in Johnson 1988.

The entire reform of the university is a good example of this problem. One thinks of the unreflected introduction of software for the administration of studies. Leaving aside the targeted, interest driven use of problem redefining technologies for a moment,[16] to leave room for the analysis of non-intentional effects that is here of central interest, the effect of an everyday heuristic leading to an inappropriately preferred technological solution becomes clear in that it even undermines its own intentions. Not taking this into consideration would have consequences for the understanding of the use of technology that undermines its intended use in everyday life. Experimental psychology delivers revealing details of this phenomenon.

For instance, the preference for technological solutions may have to do with the tendency towards the concrete described by Tversky and Kahneman.[17] This leads, as is emphasised in many classical studies by experimental psychology, to the fact that one assesses the probability of the occurrence of an event as being greater the more concretely one can imagine it. And this also leads to the fact that one prefers what can be concretely imagined and that the abstract is regularly replaced by something concrete (one speaks about time as space and, instead of about teaching, about methods).[18]

This is especially true of abstract goals lying in the future: one also anticipates these by imagining something concretely, that can equal the abstract, and then one speaks about this concrete something in place of the abstract. Technological solutions bring, in contrast to most other solutions, this property of the concrete with them. One can already recognise that this is so in the mass media's form of the fantasy of the future, science fiction. Social utopias are generally mediated through concrete technological ideas, whereby the fantasy in relation to technology is somewhat bolder than to possible forms of social organisation—as one can see when reviewing older works of science fiction, or if one looks at contemporary films and books with a somewhat critical eye.

Processes of political decision making are accelerated tremendously by this orientation towards the concrete. Thus the abstract goal of making the university more international is replaced by the more concrete, but still fairly abstract goal of rendering the performance of the students internationally comparable. This goal is then again replaced by the very concrete goal of comparing, not performance, but points.

At this level, even subsequent questions concerning the implementation have been technologised to such an extent that one only has to discuss the associated technological implementation difficulties. The task of the university now consists in the development of programs based on this doubly displaced goal, to connect the counted points with performance and then to reflect on how to deal with the

[16] The tendency to suppress technologically conditioned shifts in the problem/solution relationship almost inevitably leads to filling these contingent gaps with motive. One insinuates planning behind the use of technology, or even believes that one is able, on the basis of the effects of a technology, to recognise the true, non-communicated motive.

[17] On this cf. above all the article: *A Heuristic for Judgement Frequency and Probability* from 1973. This is not to be confused with—despite its proximity—the concept of "misplaced concreteness" from Whitehead.

[18] This is graphically described by Mary Hegarty in: *Mechanical Reasoning by Mental Simulation* from 2004.

problem that students—to the surprise of some—instead of behaving as if this doubled replacement had never taken place, concentrate on the primary goal, namely of organising their points—and treat their interest in travelling abroad simply as a surplus interest.

When one, through a technologically associated ruse, forgets its way of recursively replacing a problem, and makes technology the starting point of one's reflection, then it only appears as an instrument of power, or as a medium that, as Gamm writes, "norms and normalises, it is a regulation, a compulsion, to order the things in such a way that they can be transported within it, but in such a way that the part which the medium plays is invisible. The medium does not wish to be recognised as a medium, it is 'message', it makes itself disappear." (Gamm 2000, p. 286).[19]

However, more often than not, the tendency towards the preference for technological solutions leads not to a suspension, but rather simply to the neglect of problems not technologically solvable (or not yet technologically solvable, or not yet sufficiently technologised). This is more insidious because the subtle effect of this neglect is barely noticed and the consequences of this neglect are lost in the activity involved in paying attention to the concretely solvable problems.

This phenomenon was recognised as such very early on in relation to decisions in life threatening, stressful situations. For example, in an old Indian defence ministry manual for aspiring officers, it says:

> An important principle of Organisation design that relates to managerial decision making is Gresham's Law of Planning.[20] This law states that there is a general tendency for programmed activities to overshadow non-programmed activities. Hence, if a series of

[19] Although Gamm's suggestion to define technology in this sense as a medium cannot for this reason be taken on board, what is here of concern—one can in anticipation hint at this—is the thought of technology's own *techné*—and that in dealing with technology itself. Otherwise only a dialectic remains between a technology thought of as medium, "because it has become embodied and sedimented in the social-historical context of action" (Gamm 2000, p. 286) and is thus a medium "on the basis of the sociality of technology and the technologisation of society" (ibid., emphasised in the original) on the one hand and its indeterminacy, whether it be its "immanent" or its "transcendental" (ibid. p. 280) on the other hand. The only thing that thus differentiates Gramm's understanding of technology as medium from the "technologisation fears" of an Ernst Jünger or a Martin Heidegger is its analytically abstractly added indeterminacy, not the thought of itself as trickery. It is precisely this indeterminacy which undermines Gramm's attempt to critically think technology as something that "normalises" at the same time as him justifying his decision to think technology as a medium in that "because of its indeterminacy it has become a universal medium of exchange." (Ibid. p. 283) And further: "technology has become a medium, that is, it has transformed itself into something into which (almost) everything can be translated or in which the other can circulate." (Ibid., my emphasis) This is in the interpretation being followed here nothing other than that which will here be described as the qualitative (psychological) consequence of a quantative increase in technological things: raised to a theoretical level and *in nuce*.

[20] To be precise: no matter how persuasive the factual presentation might be, it has nothing to with Gresham's *Law of Planning*. Sir Thomas Gresham, who Thomas Hobbes also meant when he contemptuously speaks of "Those fellows of Gresham" (cf. Sect. 2.4), pointed out that from two currencies in circulation it is always the worst that will prevail because the better one (that is, the stronger one) will be hoarded and thereby loses liquidity. The expressly free transmission to decision making processes appears to have in the meantime so established itself that Gresham's Law of Planning appears regularly to be identified with this phenomenon.

> decisions are to be made, those that are more routine and repetitive will tend to be made before the ones that are unique and require considerable thought.[21]

Thus, in a free play of forces, it is not necessarily the best ideas that prevail, but rather that which survives without an idea is preferred.[22] (The crucial question is now: how can one get the German university administration to read an Indian military manual?) It is remarkable that it is the military that recognised early on that one has to educate against quasi automated routines and actions as well as the rash use of available technology. If one follows the Israeli military historian Martin van Creveld, who made a comparative study of the German Wehrmacht and the U.S. army in the Second World War on behalf of the U.S.A.,[23] then it was the German Wehrmacht, associated as it was with the image of the well oiled machine of command in the Prussian tradition, in which the chain of command fitted together like the cogs in a machine and discipline was paired with superior technology, that as an organisation understood how to counteract the tendency towards automated action and the equally automatic grasp for technology, and create space for independent decision making: via a training focussed on independent decisions, even for the lower ranks, via the targeted interruption of the chain of command both in combat as well as in the partially less reliable replenishment of staff and equipment. Thus, in marked contrast, it was the superiority in material technology which seduced the American General Staff into believing that the concrete superiority in weapons and logistics would automatically lead to military superiority.

Measured in terms of the human loss suffered in battle, which, according to Creveld, adjusted for strategic difference, lay on the American side for the whole period at around about double that on the German side, the Wehrmacht was able to compensate for their technological inferiority through organisational and pedagogic measures.[24] In Creveld's language this means that the fighting power of an army is decisively dependent upon how much it is able to work against the tendency to prefer technological and technologically affine solutions on all levels.

An initial qualitatively significant consequence of the increase in technological things could thus consist in—I paraphrase—that there are an increasing number of areas in which the first question in relation to a problem is no longer: *how* can we solve it, but rather: *with what* can we solve it. This is the first distortion. The second consists in the multiplication of the number of possible options itself.

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[21] The manual with the title: *Effective Decision Making* is published by the College of Defense Management in Secunderabad and does not carry a year.

[22] Cf. the case study from Herbert A. Simon: *Birth of an Organisation: The Economic Cooperation Administration* from 1953.

[23] The study *Fighting Power: German and US Army Performance, 1939–1945* by Martin van Creveld (1982) does not only belong to the classics of military history but is also an early example of the sociology of a decentred organisational structure which would today be dealt with under the title "governability".

[24] Creveld's attempt at cleansing this value of factors such as terrain or informational imbalances, is aimed at the isolation of these sociologically interesting factors, which he described as a whole as "fighting power".

1.4 The Use of much Technology

The tendency to make the present choice of existing technological solutions the starting point (and for the main part also the end point) for a problem solving process is only a special form of a general tendency of inappropriately overvaluing the present over and against the absent, a phenomena known as the "Feature-Positive effect". This was first observed and described in 1969 by R. S. Sainsbury and H. M. Jenkins in pigeons (Jenkins and Sainsbury 1969 and above all 1970), and has since then drawn the attention of experimental psychologists in various areas ranging from the psychology of learning to Behavioural Finance: there exists an imbalance in the assessment of the present as opposed to the absent which is hard to overestimate.

Decisions are based accordingly on the selection of that which is present, even if the number of absolute possibilities is limited and known. (This is fully independent of whether this is a real choice or pseudo choice: cf. Shah and Wolford 2007). If the number of possibilities is unlimited, unknown or both then the significance of the present is estimated to be of even greater importance.[25] This phenomenon first appears in the moment in which a choice is possible; only excess makes this possible, it does not appear under the condition of lack.

The problematic in this defect is reinforced by the tendency to be all the more certain in something the more information one has to hand.[26] And this phenomenon is once again reinforced because of the inability of even roughly estimating one's own ignorance (it is fundamentally massively underestimated: cf. Lichtenstein and Fischhoff 1977). It is no different when deciding between technological options: the larger the selection of technological "solutions", the greater the certainty that the decision for a certain technology is based upon deliberative reasoning.[27]

The second qualitatively significant consequence of the increase in technological things could thus consist in—I paraphrase once more—that there are increasingly more areas in which the first question with regards to a problem is no longer: *how* can we solve it and also not: *with what* can we solve it, but rather: *with what from that which we can here choose from* can we solve it?

Brecht's dictum that the introduction of technology is anarchic would not be the problem that it is if, as an actual consequence of its disordered introduction, its "existence" is justified (see above) and not confuse the existing order of problems and solutions just through its mere presence at hand.

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[25] This all falls under the problem of rational decision making under conditions of uncertainty. The best overview of this is still given by the anthology published by Kahneman, Slovic and Tversky: *Judgement Under Uncertainty: Heuristics and Biases* from 1982. An updated and popularised overview is offered by Taleb 2007.

[26] On this cf. Goldberg 1968 and the experiment described by Griffin and Tversky in *The Weighing of Evidence and the Determinants of Confidence* from 1992.

[27] Anyone who makes a decision in which s/he actively does something as a result demonstrates a pronounced form of engagement in pursuing this decision as opposed to those who make a decision as a result of the omission of an act: on this cf. Cioffi and Garner 1988 and Allison and Messick 1988.

The third qualitatively significant consequence of the increase in technological things can therefore already be—again paraphrased—determined, as it is implicitly here mentioned: it consists in the existence of increasingly more areas within which the first question with regards to a problem is neither: *how* can we solve it nor: *with what* can we solve it, and also not: *with what from that which we can choose from* can we solve it? It is rather: *and what problem can we solve with that which we can choose here*?

As naive as making the awareness of problems dependent upon existing solutions might appear, this phenomenon is not only widely spread,[28] it also concerns, perhaps even especially, the areas of science and intellectuals (Bourdieu 1988, 2002). When the ability to master a set of complex intellectual instruments becomes competitively advantageous to *homo academicus*, and the presentation of a solution becomes the condition of his/her success, then the orientation towards solutions and towards solution bearing technologies can easily extend to a collective loss in problems.

This also includes such theories and concepts that are used as a means for solving problems, or used as observational instruments. The loss of the problem does not even have to be noticed. The intellectual is additionally protected from criticism through the naive employment of academic freedom in which the economy of science is not taken into consideration.

One of the most impressive examples of this reversal of problem and solution in recent times is that of economic science in the last 30 years. Driven by the mathematical calculative methods for understanding economic relationships, they created the very object which could be explored using just these calculative methods: an economy that is the sum of all actions of humans who are not only rationally orientated toward their best interests but also have available all necessary information. This false radicalisation of Keynes'[29] correct way of thinking the *homo oeconomicus* model was not only the reason for numerous Nobel prizes[30] and the basis of elegant theories, whose only problem consisted in referring to a fictitious world (cf. pointedly in Munger 2003), but also served as the basis for all the "structured

[28] As soon as a decision has fallen, its motives are added to it in the most natural manner—this is also valid to a limited extent even when a decision is concerned which one erroneously believes to have made: how decisions are thus in a certain way belatedly motivated is cleverly shown by Johansson et al. (2005) in that they convinced volunteers that decisions they had not made were their own.

[29] Keynes' thought referred to the once popular thesis that moderate inflation leads to a drop in unemployment (a thesis which in Germany became popular above all through Helmut Schmidt). However, Keynes thought this was nonsense as it assumed that people were too stupid to include future price increases in their wage negotiations; inflation could thus at the most only have a short term effect on the labour market.

[30] Of which that for Robert C. Merton deserves special mention. He received it for the development with Myron Scholes of the Black-Scholes-Model for the pricing of derivative investment instruments. This is because Merton (and to a lesser extent, Scholes too) demonstrated, with the aid of the hedge fund *Long Term Capital Management*, what happens when one also believes what one claims with the aid of fictive assumptions: namely, a (near) catastrophe. On this in detail, cf. Lowenstein 2001.

finance products" which led to the last major world economic crisis.[31] However, even in the seemingly least technological subjects an economy of finding and processing problems to solutions counteracts and thereby favours a form of research which, in the next chapter, in contrast to the experimental, I will term explorative research.

1.5 Dithering as a Response

When one is surrounded by solutions, writes Vogl (2007, p. 209), but cannot necessarily find the matching problem, then one finds in dithering an appropriate attitude; this is especially true when the not-making-use of existing solutions is subject to a pressure for legitimation.[32] With the aid of Vogl's concept of dithering [Zaudern][33] as the interruption of "counterpointed [*gefugte*] time" an appropriate response to this reversal of the sequence of problem and solution lets itself be described; a reversal which, as a result of the recursive identification of the matching problem with a present solution, becomes invisible via the impression of a linear time and behind which the transcription of the present past becomes lost beneath the impression of a pronounced present future.

The view, in the meantime widely spread, that the present past is fundamentally distinguished from the past present, probably belongs to the type of view the popularity of which is owed to the attractive combination of critical gestus and a lack of consequence. The gestus of this view becomes critical in the manner of the semi-educated "reduced to mere cunning", who "cannot be fooled" (Adorno 1972, p. 115). And this gestus lacks consequence for as long as the effect of the everyday heuristic (which is characterised precisely by the undermining of that which one believes to master in the form of knowledge) is not subject to a practical resistance which, with Vogl, can be described as dithering, but is not exhausted by this.

This will be the subject of the next chapter. In this generalised form, which is more a danger than a help, the view that the present past is fundamentally distinguished from the past present suggests the continued sovereignty qua "critic" and

[31] The view that they thereby oriented themselves according to the natural scientific ideal could well be presented as a one sided judgement: "Whenever I even hear that word: structured securities. Really, as a scientist I understand under structured something completely different." (Jürgen Hambrecht in an interview with the Wirtschaftswoche from 22.8.09).

[32] The ideas for combining dithering with the challenge of technology originate from a collaboration with Anne Brüninghaus and were first sketched out in a lecture in Hamburg University (2009) bearing the title *Technisch bedingte Entscheidungsprozesse aus bildungstheoretischer Sicht am Beispiel Gendiagnostik (Technologically Conditioned Decision Making Processes from the theoretical perspective of Bildung using the Example of Genetic Testing)* at the department for *Technologiefolgenabschätzung der modernen Biotechnologie in Medizin und Neurowissenschaften (Assessment of the Consequences of Technology in modern Biotechnology in Medicine and Neuroscience)*.

[33] Trans. translated by Helmut Müller-Sievers as tarrying (Vogl 2011). I prefer the word dithering because it better contains the sense of indecisiveness carried by Zaudern.

thereby seduces one to seek the solution to the problem of the confusion of the problem-solution relationship in ironical distance (see Sect. 3.11), instead of embarking on the search for that which is thereby threatened with obscurity. In other words: the recursive replacement of a problem alone is still not a reason to dither, it requires an occasion (see Sect. 3.3).

That the not-making-use of existing solutions is subjected to a pressure for legitimation is, otherwise than as suggested by Vogl, certainly not only a phenomenon of time. Ditherers, doubters and the indecisive have never had a particularly good reputation. For example, Sophocles says: "The heavens never help those who do not want to act". And in Goethe one can read: "There is nothing in the world so pitiable as an undecided man".[34] Thus, it is those who cannot decide for dithering that are bereft of God and pitiful. And it is not seldom that this estimation also coincides with one's own feeling.

However, this should not now be about defending indecision per se or, vice versa, participating in the insulting of the Bartlebys of our time, but rather to assume with Vogl, that some of that which affects outsiders with the impression of mere passive indecision and a reluctance to act is, in fact, an active or, more precisely, an active-passive and absolutely appropriate response both to certain situations as well as—put more generally—against a possibly time specific imperative for action.

Vogl terms this active passivity which interrupts a counterpointed time, and represents a break with an economy of finalisation, the solution orientated bringing-to-a-conclusion, dithering. Dithering can be understood as an indication of something that is not opened up in the linearity of the succession of problem and solution. In that there can never be a clear occasion for dithering—one does not know exactly what is missing—and in this manner, at least to some extent, in that it undermines the will of the subject towards a solution striven for intentionally, dithering can be understood as a minor form of resistance, in the sense of a replacement for the failure of failure, brought about "through multi-optionality".

Vogl's initial example is not technology and the increase in options associated with its increase, but politics, which, according to him, are presently characterised by a hegemony of opportunity. This hegemony of opportunity described by Vogl can be seamlessly integrated within the previous diagnosis of the increase in options. According to Vogl, a new politics of "targets of opportunity" has established itself,

> that does not like to miss the opportunity to act, for the first, second or preventative strike. What power means is proved by the fact that one can, despite all confusion, mobilise, deploy and strike at any time. 'Opportunity' is a door or portal that has just opened; and no matter how the end or the purpose (telos) of an initiated course of actions might look, the crucial strike is aimed at the target (skopos) immediately sighted in this opening. (Vogl 2007, p. 110)

Here, Vogl refers to Samuel Weber who equally, or more precisely, took exactly the same politics as an example in order to investigate the suspicion that the present characterises itself through the tendency to grasp for opportunistic targets. He illustrated his thesis and begins with a quotation from the New York Times from 22nd March 2004: "Less than a day after the attacks [on September 11, 2001],

[34] And that in Clavigo, SCENE I. Clavigo's abode. Carlos, alone.

Donald H. Rumsfeld, the secretary of defense, said at a cabinet-level meeting that 'there were no decent targets for bombing in Afghanistan and that we should consider bombing Iraq' instead because it had 'better targets'.".

Weber sees this politics of targets of opportunity not as the temporary interlude of a single government of a single country, but rather as a symptom of a specific and widespread attitude of opportunity characterising the present. Accordingly, he believes to have made out a conjuncture and a shift in meaning of the word "target", and sees this conjuncture itself as a symptom (cf. Weber 2005, pp. vii–x).

Admittedly, talk of opportune targets has above all a military history—Weber here refers to the orders to American air force pilots in the 2nd World War to keep an eye out for opportune targets beyond the plan of attack as one of the earliest examples of this change—but it has since spread to other areas; for example, it has become common in the appeals procedures in American universities (ibid., p. 4). The words "targets of opportunity" are thereby only an example of a larger semantic field of opportunity, the conjuncture of which Weber cites as a symptom of the tendency towards first strikes. Another example of a word that has trickled down, also drawn from the military into other areas, especially in the (anyway military affine) management literature is that of acting "proactively".

Vogl and Weber both speak of opportunity as if it were, above all, a cultural peculiarity of the present. According to Vogl, dithering "found its shadowy historical place initially everywhere where a hegemony of addiction to consequences, a finality in a chain of actions and an inevitability in the sequence of cause and events has become manifest" (Vogl 2007, p. 109).

And in Weber the subject of opportunity is seen from the perspective of an increasing militarisation of *thought*, an increasing *orientation towards* targets of opportunity. That it is probably the targets of opportunity that have themselves increased is only implied by Weber. Even more: although he hardly brings forth any examples in which non-technological changes are at the centre of the transformations described by him, and the new order that he describes is hardly better characterised than by the entanglement of technological, organisational and cultural elements, it is still finally only the "narrations" at which he aims his argumentation.

That it is the present that is characterised by "a hegemony of addiction to consequences, a finality in a chain of actions and an inevitability in the sequence of cause and events", does not move Vogl to explicitly question technology's contribution. If he questioned its role in this respect more closely then it is quite possible that he could make do without the construction of an attitude having a hegemonial status. In both authors one finds technology as a barely explained, but constantly accompanying background; so it is when Vogl compares the relationship of the individual to a functionally differentiated society with its utter lack of a control instance to the relationship of human beings in the ancient world to the gods:[35] whereas dithering in

[35] The only appropriately detailed and complex depiction of the present as one which is characterised by the absence of a central controlling instance known to me—with the exception of Luhmann—can, by the way, be bought as a DVD; I mean the series *The Wire*. David Simon, who developed the series, explicitly says that he based the writing of the script on Sophocles and not, as had been normal until then in HBO, on Shakespeare—the situation of people today resembles

the ancient hero marked "the flow or the drift away […] with which one could wrest oneself from the actions of decisive gods, the vehemence of their interventions and their prevailing skill, and make the shift to earthly areas of competence" (ibid.), it is with both authors, technological changes above all, that enable this "addiction to consequences" and increase in targets of opportunity.

This can already be illustrated using the example with which Weber begins: the bombardment of the house in which it was suspected that Saddam Hussein would be in and which set the prelude for the second Iraq war: it is plainly a reduction of the problem to here ignore the technological possibilities offered by satellite controlled target acquisition and camera guided unmanned drones and to simply talk of a mentality of opportunity. It is analytically crucial to point out that with these technological options one is dealing with a multitude of opportunity portals which stand open independent of any mentality.

Due to their material exteriority (cf. Stiegler 1998, p. 141; Stiegler 2009a, p. 127 ff.) no special effort is required in holding them open, they can, for the same reason, also be accumulated and are thus available to changing political "mentalities". Only so does the not-making-use of an openly perceivable option inevitably lead to a pressure for legitimation.

In contrast to the historically contingent event in time and space, technologically caused opportunities can actually be increased—and this has consequences. One can investigate these consequences without assuming, on the one hand, a "technologised" society, or, on the other hand, a completely consciously rational use of technology as a tool.

Thus, Vogl and Weber point out an important aspect which has until now remained unconsidered in the question regarding the qualitative changes of the quantitative increase in technological things: technology does not just present itself with a further option which one could grasp, so that the increase in technological possibilities or "targets of opportunity" is multiplied, it also works mediatively by increasing options. The aeroplane has not just added a further possibility to the possibility of travelling from A to B, but has also increased the number of places where one can actually go on holiday.

And, remaining within the circle of Weber's examples, it has also increased the targets of opportunity in the military sense; whether it be as a means of achieving more and different targets, or whether it be in the form of a target of attack itself. That the classical war on a front no longer has a strategically relevant role and has been replaced by that which Weber, drawing on Arquilla and Ronfeldt (2001) has called "Netwar", does not provoke, as Weber would have it, the question as to what holds these networks together, and is also not in proximity to Weber's answer: namely narratives.

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much more the peoples of ancient times, subjected to the will of the unpredictable moods of the gods (Simon 2006, 2007). The reflection of the present in the film is here too obviously bound to state of the art technology. For the depiction of a subsuming complexity in which the significance of people individually acting is, against all the habits of watching, reduced to a minimum, so that they can be *presented* as being expendable, requires firstly time, which is not available in a cinema, and a density that is unachievable with a weekly broadcast television series. (Cf. Ahrens 2011).

However, to claim the reverse, that it is technology alone that binds these networks together, would also be false.[36] It rather shows more than clearly that the conditions of war have so drastically changed after the appearance of new technology that even the most simple of military questions have become problematic in a fundamental fashion; questions such as those regarding the enemy, allies, superior strategies, right up to questions about war itself, such as, for example, how one can recognise that one is actually at war, when it began, and when and whether it has ended, and whether one lost or won.

That the excess of technological possibilities itself represents a problem that has fundamentally changed the handling of technology is a view that is presented in the prelude to the second volume of Günther Anders' writings "Die Antiquiertheit des Menschen" ["The Antiquity of Mankind"]. In § 3, under the heading "Variations of the 'Promethean Descent'", Anders radicalises the observation that made up the prelude to his first volume, which appeared 25 years earlier. At that time, he thought he could make out a considerable descent "between the maximum that we can produce and the (shamefully low) maximum that we can imagine." This is what he characterised as the "Promethean Descent".

What has now changed in the quarter of a century between the two publications is the descent itself: out of this "now even […] a *descent* has developed *between that which we produce and that which we can use*. We desperately hunt down questions for the answers we already have, so that we can belatedly legitimate them; we continue to untiringly produce new products in order to fulfil this new task (namely, that of finding new tasks)." (Emphasised in the original, Anders 1980, p. 18).

However, Anders remains at the level of the phenomenon of increase and excess, while leaving unconsidered the problem of the recursive identification with the appropriate problem matching the given solution as a principle of technological translation (such as in the example of the dishwasher), so that the problem that concerns Anders is limited to one of *quantity*. This is shown above all in his work on the concept of need, which is abstracted to the point of indifference. He writes:

> In fact we can provide our 'promethean descent' with another [further] version. For this now exists between *the maximum of that which we can produce and the* (shamefully low) *maximum of that which we can need*. Indeed, no matter how contradictory that might sound: 'can need'. […] Our present day mortality no longer consists in the fact that we are *animalia indigentia*, needy creatures; rather, conversely, that we (much to the regret of the inconsolable industry) can only need much too little—in short: in our lack of lack. (Ibid., p. 19, emphasis in the original)

Anders' observation of the promethean descent between "*the maximum of that which we can produce and the* (shamefully low) *maximum of that which we can need*" that has widened to an abyss, looks naive from today's perspective (another 25 years on).

[36] An overview of the changes that war brings, especially, but not exclusively, focussed on the technological as well as the infrastructural side of the military can be currently found in Creveld 2008. It is thereby noticeable that Creveld in these more recent publications about the history of the war assigns technology a pronounced role in the change in carrying out wars, while in the comparative study concentrating only on the 2nd World War *Fighting Power* from 1982 everything arose from organisational factors.

A situation that would have been correctly described in this way, if only reserve, but not necessarily dithering, was required.

Quite obviously, Anders assumes something like an anthropologically constant limit to needs—as if there had not been impressive progress in the area of, if one may term it so, needs creation technology. One may, if one follows Bernard Stiegler, and he has good reasons for saying so.[37]

Stiegler assumes a limitation as well, except that it is not a limitation of the ability to need,[38] but rather more simply a limitation of time that an individual can give something a certain amount of attention—and here we really do have a problem.[39]

It is the consideration of the effectiveness of advertising that brings him to understand it as a technology for controlling attention. However, accusing Anders of a failure in prognosis because of this would be unjust. When has there been a vision of the future related to technology that was not simply a projection of progress in the future based on present day needs, but also included a transformation of the structure of needs itself?[40]

Neither can one accuse Peter Gross of a failure in prognosis when he observed an excess of effective advertising opportunities, bringing them under the formula of the "multi-option society" (Gross 1994), and dedicated a whole monograph to the problem. Gross is, in fact, a contemporary, and thus has a different problem to that of a failure in prognosis. Including Gross here can be justified by the fact that, in his description of the increase in options in a harmonic unity of form and content, one

[37] To remind once again, whether the concept of technology is legitimate is here not to made dependent upon the state of that which is here concerned, but rather from the way in which it is deployed. Thus, in this case, it is not the advertisement in its aesthetic or dramatic or, more plainly, its communicative aspects, that is here crucial, but rather only the actual technological aspects; that means, insofar as it represents a functioning means to draw attention to itself or at least to provoke. From this point of view it is better compared with the blinking and bleeping oil warning indicator in a car or a siren, than with a film or a radio play. The word "advertising" is on the contrary a euphemism, with which advertising advertises itself; it is a term that lays claim to interaction where none takes place, and suggests cleverness where there is none, by using the semantic of the gallant.

[38] Stiegler appears to implicitly orient himself according to the Lacanian difference between desire and enjoyment. Insofar as need accords more with desire then this would anyway be in principle inexhaustible or unfulfillable. Advertising promises, as Stiegler describes them, in contrast aim more at enjoyment than at desire (Stiegler 2008, p. 22 ff.; Lacan 1991).

[39] Cf. this approach also with Georg Franck: *Mentaler Kapitalismus. Eine politische Ökonomie des Geistes* [*Mental Capitalism. A political economy of the spirit*] from 2005 as well as his introductory work to this book, which appeared in 1998 under the title *Ökonomie der Aufmerksamkeit. Ein Entwurf* [Economy of Attention. An Outline]. A more general connection between the development of need and technology is to be found in Gamm, who sees the development of technology itself as an object of want: "Technology has integrated itself into the structure of our drives just as the order of language has in our perception of self and world. Nowhere is it as easy to recognise as in the wishes immanent in, for example, the finitude and mortality defying technologies, the medicine of reproduction and artificial intelligence, desires which motivate the development of technology just as they are themselves conditioned by progress in technology which just as equally lastingly reforms them as newly created." (Gamm 2000, p. 299).

[40] In a certain way one could here name the novels from Philip K. Dick and Stanislaw Lern as exceptions.

can observe what happens when one is able to describe the problem but, at the same time, makes no place for dithering.

1.6 Responding Without Dithering

Gross also sees the present being characterised by both a proliferation of options together with the simultaneous existence of a subtle pressure to pay attention to the options on offer. Gay marriage, new reproductive technologies, trans-national identities and, above all, as a component, trigger and catalyst: new technological possibilities form his examples for the proliferation of options—and all this plays its part in complicating life.

The proliferation of options presents a problem for Gross and is, just as with Anders, exclusively isolated and regarded under the quantitative aspect. Through this simplification of an already simple idea, he limits the problem of the proliferation of technological things, and the consequences of social pluralisation to the "proliferation of options", and, correspondingly, he limits the solution to exercising restraint in utilising options.

The only tenable position in this understanding of the problem is thus necessarily a conservative one, if not even a reactionary one—if one remains close to the narrow meaning of this concept. As such, Gross does not have to take a position towards several aspects, it is fully sufficient that he draws a "critical position" to the "multi-option society"[41] designated by him as such, whereby he positions himself against the proliferation of options, and opposes it with "resting", "stopping" and "pausing".

The reader, whose complicity he is always assured of through continually renewed examples drawn from everyday life, thus has no problem in distinguishing between the dangerous new option and that which should not be recognised as a mere option. And the reactions—and not just in the feature pages—show that this has been understood. Thus, Manfred Prisching interprets Gross so:

> The objective pluralisation of life-forms is complemented by the impression of an even more global pluralisation because the representation of relatively seldom life-forms by mass media suggests their omnipresence according to the rules of the economy of attention—such as communes, separated cohabitants and same-sex partnerships. The periphery, the seldom and the anomaly are stylised as the everyday, and everyone who is astonished at this, to anachronistic contemporaries of yesteryear. (Prisching 2006, p. 66)

How quickly this conservatism can turn into simply religious belief is demonstrated by Peter L. Berger, who grasps the proliferation of options simply as relativism, and attempts to find purchase in the transcendental (cf. Berger 1990, esp. p. 75). That the appearance of an alternative also renders the status quo an option, tearing it from

[41] The "multi-option society", against which Gross takes a critical stance, is indeed his own construction.

the darkness of the self-evident into the light of the merely possible, so that one cannot, above all, reverse this, all that is not *allowed* to be spoken of.[42]

That the appearance of new options changes the world qualitatively and not just quantitatively, whether one makes use of them or not, does not even cross Gross's mind. This is not a coincidence, but it completely undermines the position from which Gross speaks and from which he wishes to criticise the "multi-option society". There would immediately no longer be any space and no duration in time in which one could refuse "optionalisation" and "resting", "stopping" and "pausing".

Gross would have to dither in his writing in order to notice this. Dithering would allow him to break out of the linearity of his writing and to recognise the necessary recursive transformations of the past through the appearance of options in the present—something which presupposes decisive backward references. However, dithering has no place in his work, neither with reference to the written, nor with reference to the writing.

Congruent in form and content, Gross rushes from one possible example to the next, while only seeing the possibility of "stopping" or "realising options". And the alternative to recording every example on offer in Gross's lived logic means not-writing (and one would have to justify "why one does nothing"). It appears not to strike him how much he himself represents the best example of his analysis when he writes—and he is here writing about his writing: "the increase in the possibilities to act is so present and evident that it is difficult to take a fitting example for this process from the thousands available. […] The number of viable possibilities is much larger than could ever be included in even the thickest book. History itself appears as an exponentially growing library of books filled with possibilities." (Ibid., p. 15).

The result: a 400 page long sequence of examples without a single recognisable dither. This is analytically interesting insofar as Gross demonstrates the necessity of thinking the handling of the (technology inducing) proliferation of options as a break with the linearity of time, and not simply as a reaction to a proliferation of options itself.

At first glance, the concept of dithering that Vogl introduces as a reaction to an "attitude of opportunity" is in line with the Grossian concepts of "resting", "stopping" or "pausing". A second perusal reveals a crucial difference between Gross's anti-opportunity-concepts and Vogl's concept of dithering in relation to the same problem, and that this difference allows the concept of dithering its strategic position in the preparation of a theory of technologically enlightened *Bildung*, without needing to especially elaborate this. Dithering, according to Vogl, interrupts the counterpointed time of a "chain of events and actions" (Vogl 2007, p. 48), the elapsing, chronological time.

One could express it more straightforwardly and precisely: what characterises dithering in opposition to "pausing" and so on, is its paradoxical relation to time (ibid., p. 49). It has its strategic place between the present future and the future present. It is an active passivity having the aim of maintaining an oversupply

[42] One sees this half hearted analysis in the vulgar interpretation of "post modernism" in which it is equivocated with relativism.

of possibilities for thinking possibility. Vogl talks of a dithering function: "In dithering, a critical, crisis-like relationship between action and inhibition, action and reason, law and execution crystallises; and thereby the basis upon which a world, a world relationship, is constituted, is inevitability stirred up." (Ibid., p. 25).

In other words, it is easy to orient oneself towards possibilities under the conditions of lack. It is also easy to desire lack in an oversupply of possibilities. However, it is difficult to unlock and hold open a possibility from among a sea of possibilities. This is, however, not recognised as a problem in the formulation of a concept of *Bildung* in which the qualitative meaning of the quantative proliferation of technology is not adequately taken into consideration and makes a technologically enlightened reformulation of the concept of *Bildung* necessary: *when lack is lacking then failure is not something that one can rely upon.*[43]

1.7 The Condition of Failure

Without utilising the concept of dithering or of opportunity, and without referring to the question of technology, but with a decisive focus on the temporal-structural conditions of *Bildung*, Andreas Dörpinghaus places *Bildung* in a relation to delay which, like dithering, is understood as the enabling of a space for playing or creating in time, which is vital to *Bildung*. He thus places himself in the same tradition going back to Schopenhauer and Nietzsche of thinking *Bildung* in relation to a non-economised time and, like Adorno and Horkheimer, represents *Bildung* from the aspect of a reaction to a thoroughly rationalised handling of time (above all, cf. Adorno 1972; Horkheimer 1985/1952).

According to Dörpinghaus, *Bildung* is only thinkable from the background of a creative space in time, a creative space which is opened in the form of a reaction, "a re-flectivity, which opens and keeps open something which would otherwise be shut off, and which breaks through a given order" (Dörpinghaus 2005, p. 566). And, taken strictly, this means not only a delay, as Dörpinghaus terms it, but rather a break with the linearity of time: "only in the *non*-linear interconnectedness of time are experience and a being-towards-the-world describable" as Dörpinghaus specifies with reference to Husserl and Merleau-Ponty (2005, p. 567). Even if *Bildung* is of course not identical with delay (2003, p. 24), it is still necessary to understand this delay as a condition of *Bildung*. Just as Vogl grasps dithering, Dörpinghaus also understands delay as interruption:

[43] "The whole traditional instrumentalism, the limited view of which grasps technology sometimes as an extension, sometimes as a replacement, sometimes as a mere projection of the human, is distilled from a picture of thought in which the reference to the world of existence and the existing among themselves stand under the law of lack. The dogmatic image of technology that is still circulating in the long ago technologised sciences, is nothing other than the concretion of the ontology of lack. This, however, covers over the real problem of technology, technicity and machines: that we, without cease, and *without us lacking in anything*, create formations with technological objects, animals and other people." (Hörl in Stiegler 2009a, p. 19 f.).

> In the delay, as an initial consideration, the immediate reaction, an immediate effect is turned back and inhibited, so that a space for play emerges in the transition from mere pragmatism to reflection […] In other words: in the delay, something which quite possibly urges progression and fruition is delayed, so that another reflective level is brought into the temporal execution. Within this, something can then become visible or show itself, which would have otherwise remained hidden. That which perhaps was already counted as completed, is maintained in its openness. (Dörpinghaus 2003, p. 24 f. and in almost the same formulation Dörpinghaus 2005, p. 566)

Analogous to the distinction between problem and solution chosen here—because of its proximity to the semantic field of technology—he continues with the distinction between question and answer and, with the help of Waldenfels, differentiates between various question/answer relationships: those in which a completed structure is formed and those in which an opening appears or can be opened through delay.

Waldenfels counts "asked questions" and "interrogative questions" to the former, in the context of a completed structure. Asked questions and interrogative questions do not *need* delay, the answers can naturally be delayed, but in this case only *finding* the correct answer is of concern. Asked questions ask after something which is already there: who discovered America? Who discovered penicillin?

Interrogative questions refer what is questioned to the question itself: it deals as such with open questions as it deals with questions in which the question "holds itself as a question in question" (Dörpinghaus 2003, p. 27). Dörpinghaus, however, is interested from the perspective of the theory of *Bildung* in the question in which the question-answer-order itself comes into question in a confrontation with an other (that is lacking in the self-referentiality of the interrogative question). For only this would "tend toward delays that the scope of *Bildung* makes possible" (ibid.). Such a question can only stem from the other[44] if it is—still with Waldenfels—"an answer to the demand that is made *within the question*" (ibid., p. 28).

> If one places the development of processes of *Bildung* in reference to itself (ethos), to others (pathos) and to a matter in hand (logos), then the simultaneity of such relations of *Bildung* are only to be thought if *Bildung* is also always thought, and not as a side affair, from its other side, as withdrawal. The withdrawal of oneself, the other and the withdrawal of the determinacy of the object. (Ibid.)

Dörpinghaus undertakes no further reaching attempt at more precisely defining the temporal structure of delay. However, it is already clear in these three shorter texts on the necessity (with reference to *Bildung*) of delay, to what extent the metaphor of "creative space" meets its limits in the attempt to think a break in the linearity of time and calls for a decisively grasped temporal structure, a structure which will be more precisely theoretically determined as a part of the experimental in the next chapter.

And why, even if this question is repeated here, is technology never of concern in Dörpinghaus, when the idea of an accelerated time, as he writes, is dependent

[44] Of course, this is not just a problem with a personal other: "this other can be another, a thing, which is to be understandably answered, yes, even oneself is, because of one's bodily-linguistic existence, another" (Dörpinghaus 2003, p. 28).

"*exclusively* on technological progress", symbolised by the railway (2007, p. 40, my emphasis)? Was the railway then no more than a symbol that retrospectively matched an accelerative tendency as a result of a linearization developed independently of technology?

He writes—and this time the emphasis comes from him: "this *idea* of a linearity of time finds its life-worldly plausibility and vindication in the tracks of the railway" (ibid., p. 40). On the other hand: "Not that speed did not play a role in the life of humans before that. The furthering of the mechanics of a watch to include a minute hand in the sixteenth century, and a second hand in the seventeenth century makes this clear. Even the speed of the horse drawn carriage doubled in the first half of the nineteenth century. The same is true of shipping." (Ibid.).

Perhaps this is a question which cannot simply be dealt with just by indicating that technology did not really interest him; possibly—to test this thoroughly requires a more extensive textual basis—it has to do with what was spoken about at the beginning of this chapter: Dörpinghaus sees technology as a trigger, perhaps even a pace setter and catalyst for a fundamental transformation in the temporal structure and a consequent process of acceleration. Beyond this, he does not take technology into consideration. But even processes of acceleration and temporal structures are not isolated social facts that can exist in themselves, independently of technology. They must, in dealing with technology, (which Dörpinghaus himself marked as being crucial) continually be repeatedly renewed and confirmed—if it does not come to a shift within this repetition.

The forgetting of technology as the irreducible "medium of self and world disclosure" (Gamm 2000, p. 285) in everyday life corresponds to the forgetting of the world disclosive function of the experiment in natural science insofar as in both cases the iterability of technology is falsely hedged in by the ideality of their repeatability.

Dörpinghaus also points out that transformations renew their potential in each repetition, but he only speaks of the self referral of the subject in language and never about the self referral of the subject in dealing with technology: "the delay can, in this sense, be described as anaphoric; it falls under a different light in the repelling movement of a repetition of the repeated. Thus the delay in time creates within the anaphor and the repetition a *difference*, which is characteristic of processes of *Bildung* and learning. This difference is not between the utterly distinguished, otherwise it would not be a repetition, it is, however, not between the identical, otherwise it would not be a difference." (Dörpinghaus 2005, p. 569).

It is probably no coincidence that Dörpinghaus uses to illustrate his ideas of *Bildung* as delay, the example of the physicist Heisenberg, of all people, of whom his vive voce examiner Wilhelm Wien attested a "bottomless ignorance" of experimental physics, and who sees, "although stylised, the starting point for the development of his theory" in the reading of Plato's Timaeus.[45] "The reading of Plato, really only meant as a Greek refresher, created in Heisenberg disquiet and in a certain

[45] On Heisenberg's career cf. Lindley 2008.

manner, movement, in that it placed an assumed order in question. […] [T]his experience accompanied him his whole life" (Dörpinghaus 2005, p. 571).[46]

It is probably also no coincidence that not a single example drawn from the field of natural scientific technology occurs to him when he searches for possibilities for occasions for delay in the field of didactics: "So might, for example, delayed reading and writing processes as forms of linguistic delay, be useful, just like delays in the perception of art images and conceptual images, the conflict around controversial interpretations and perspectives, or even (correctly understood delaying) scenic play in which the plot creates delay." (Dörpinghaus 2003, p. 31) In a strange reversal of the technology affine everyday heuristic the theory of *Bildung* appears to tend towards the substitution of the concrete with the abstract and the technological with the non-technological.

Dörpinghaus writes that *Bildung* can indeed only be thought from the background of a creative space in time, which opens itself in the form of a reaction, "a re-flectivity, which opens and keeps open something which would otherwise be shut off, and which [through a break with the linearity of time] breaks through a given order" (Dörpinghaus 2005, p. 566), with the aim that within it "something will then become visible or [can] show itself, which would otherwise remain hidden" (ibid.).

Thus he sketches in broad outline exactly that which is to be more precisely theoretically accounted for in the following with the aid of the concept of the experiment. For, if there is a lack of lack, and failure is no longer something that one can rely upon, then it is the experiment that is the sole form in which it is possible in an excess of possibility to open up and maintain possibilities for "something" "which would otherwise [without this reflectivity] remain hidden".

In order to do this it is firstly necessary to more precisely determine the concept of the experiment and to show that it is *not* a metaphor borrowed from the natural sciences. This is what will be covered in the next Chap. 2. In the course of this, the concepts of *Bildung* and world should also be determined to such an extent that *Bildung* can be determined as the experimental form of world disclosure applied to the individual.

In Chap. 3 this determination is rendered plausible in the following by showing the characteristics of experimental world disclosure using the example of the natural sciences. Whoever experimentally discloses a world does not imitate the natural

[46] If one did not listen to what Heisenberg said about his work in the evening, but instead looked at *how* he worked then one would see that it was not the "bottomless ignorance" of experimental physics that lead him to his breakthrough in quantum physics, but rather the crucial focus upon that which showed *itself* in the experiment. That Heisenberg made the relationship between experimental and theoretical physics to his problem is already shown in the first sentence of the article about *Quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen (1925)* [*Quantum Theoretical Reinterpretation of Kinematic and Mechanical Relationships*], which marks the beginning of quantum physics:"it is well known that the formal rules which are used in quantum theory for calculating observable quantities such as the energy of the hydrogen atom may be seriously criticized on the grounds that they contain, as basic elements, relationships between quantities that are apparently unobservable in principle, e.g., position and period of revolution of the electron. Thus these rules lack an evident physical foundation, unless one still wants to retain the hope that the hitherto unobservable quantities may later come within the realm of experimental determination." (Heisenberg 1967, p. 261).

sciences. It is the natural sciences that have taken up this general form of world disclosure and have reinvented it with the help of a ruse (*techné*).

A further task of the next Chap. 2 consists of understanding this ruse, which still today awakes the impression that the experiment is an invention of the natural sciences, and stands exclusively available only for them. That the division [*Teilung*] of the world introduced into the world by the experiment is, as such, covered over, should be rendered plausible in that the significance of *techné*[47] for the understanding of every experiment will be investigated and related to the divisions[48] [*Teilungen*] to which the experiment at the same time represents an answer.

The arguments carried out in Sect. 3.11 and Chap. 4 that the covering over of the division [*Teilung*] introduced by an experiment into the world is maintained by repressing—in a certain way—the laughter which would reveal the humour [*Gewitzte*] of the experimenter's tricks, will thereby be prepared. The laughter is repressed in that one degrades technology to a mere tool—for the tool is that form of technology which can be utilised without the cunning [*Gewitztheit*] of *techné*. The crucial step with which the tricky character of technology is covered over consists of understanding the experiment itself as a tool.

Via the detour of freeing the experiment from that which is termed the explorative thought system[49] in the following—a thought system in which technology can be exclusively thought of as a tool—the attempt will be undertaken to open up the understanding of *Bildung* in relation to *techné*. One can correspondingly understand this as a plea not to repress the laughter in the discussion of processes of *Bildung* that might free the critical moment of *Bildung* from its tendency towards conservatism.

[47] The word *techné* serves in the following to signal the tricky/cunning in the use or handling of technology. The trick here depends on technology—not on the subject. For, since the subject is not, like an engineer, able to construct a trick, but can rather only exploit the potential of a given situation (in the sense of an orientation according to efficacy, as described by Jullien 2004), it finds itself in the effective area of the trick, over which it has no sovereign control.

[48] On the concept of division [*Teilung*] and co-mmunication [Mit-Teilung] see Sect. 2.10 and the first footnote in Sect. 3.3.

[49] On the concept of the thought system see Sect. 3.23.

Chapter 2
The Disclosure of the World

2.1 Techné

> All experimentation is technically implemented
>
> —Hans Jörg Rheinberger 1997, p. 141

"[W]hereof one cannot speak, thereof one must be silent" (Wittgenstein 1922, p. 23) and instead speak of something other. What exactly is spoken about when talking of *Bildung* remains subject to disagreement. However, according to Koller, the fact that educational processes are not simple to observe, must surely "be a matter of agreement in the debate in the theory of *Bildung*", despite "the many differing concepts of education" (1999, p. 161). If the subject here is not observable, then the question as to the strategy through which one can nevertheless disclose it becomes the all decisive factor.

One of the common strategies in quantitative research is to talk about training instead of *Bildung*. One of the common strategies in qualitative research consists of talking about narratives about educational processes instead of educational processes themselves. And a common strategy in theories of *Bildung* is to talk about texts about *Bildung* instead of *Bildung* itself. The strategy followed here consists of talking about the history of protein synthesis in a test tube instead of about *Bildung*.

Put a little less pointedly: on the basis of already well researched processes of world disclosure organized according to the division of labour, especially in the natural sciences and with special attention to Rheinberger's work, an attempt will be undertaken to gather the general characteristics of the processes of world disclosure

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Translators's note: Erschließung—I follow Macquarrie and Robinson in their translation of Heidegger's usage of the term Erschließung which is being referred to here. Cf. their footnote: "In ordinary German usage, the verb 'erschließen' may mean not only to 'disclose' but also—in certain constructions—to 'infer' or 'conclude' in the sense in which one 'infers' a conclusion from premises. Heidegger is deliberately ruling out this latter interpretation, though on a very few occasions he may use the word in this sense. He explains his own meaning by the cognate verb 'aufschließen', to 'lay open'. To say that something has been 'disclosed' or 'laid open' in Heidegger's sense, does not mean that one has any detailed awareness of the contents which are thus 'disclosed', but rather that they have been 'laid open' to us as implicit in what is given, so that they may be made explicit to our awareness by further analysis or discrimination of the given, rather than by any inference from it. (Heidegger 1962, pp. 105–106)

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and, with respect to certain individual processes of world disclosure, their re-specification will be attempted or, at the very least, the possibility of their re-specification will be made clear.

Therefore, the strategy chosen here to deal with the impossibility of directly observing educational processes does not consist in nevertheless attempting to do so in a direct fashion, nor does it consist in reconstructing them on the basis of their narrative traces, but rather consists in following a detour of abstraction and re-specification.

Here, two forms of the processes of world disclosure will be distinguished: the explorative, which, when applied to the individual, will be termed learning, and the experimental, which, when applied to the individual, will be termed *Bildung*. It remains to be demonstrated that this distinction is legitimate.

If, in the following, *Bildung* is not always talked about, then this is not because the talk is of something else, but rather that the detour holds out the hope that, in the end, it can be legitimately said that the whole time it was *Bildung* that was being talked about—not because experimental science and *Bildung* are the same (which is not the case), but rather that both are concerned with experimental forms of the disclosure of the world.

This strategy is guided by the speculation that *Bildung* will be less misrepresented this way than if one approaches the subject in an apparently direct manner. Although it has not yet been elucidated that the abstract analysis of the characteristics of experimental research is guided from the outset by the educational-theoretical focus on the possibility of the re-specification as applied to the individual, it should nonetheless be apparent.

An alternative strategy of this kind must be, singularly and exclusively, legitimated on the basis of its outcome; and also, in this outcome, not as to whether a correspondence between theory and object is evident, but rather in that something becomes recognizable with which one can make use of in the future.

An either-or in the choice of empirical access is anyway absurd, given the absence of any comparative fundament. However, the strategy of a detour of abstraction and re-specification can only be taken on board if one accepts that the outcome of a work (in this case: *Bildung* and scientific experimentation can both be understood as different forms of the process of experimental disclosure of the world) can be used for its own legitimisation (*Bildung* and scientific experimentation are simply different forms of the process of experimental disclosure of the world). This is forbidden in classical logic.

Such a strategy is already opportunistic (in the sense of an orientation guided by given options), but, at its very opening, presents the initial problematic of this work in another light. Originally, the question was not: “what are the characteristics of an experimental disclosure of the world?”, but rather: “What is the relationship between *Bildung* and technology?” Therefore, this line of argument does not pose an intended processing of an initial problematic towards a solution, but rather the grasping of a particular opportunity on offer, in which an apparently unsolvable problem (“What is the relationship between *Bildung* and technology?”) is substituted *ex post* by an approachable problem (“What types of world disclosure are there and how are they characterized?”) after discovering what its solution is (experiment and exploration).

And still there exists a connection between the original problem and the unsought solution; now the relationship between *Bildung* and technology can be reformulated

in the light of the differentiation between experimentation and exploration. That this relationship no longer occupies a prominent space does not change the fact that technology, understood here in the sense of a ruse, a *techné*, in the analysis of *Bildung*, can no longer be ignored.

The answer to the question as to whether the approach sketched here can be seen to be a legitimate form of knowledge at all (or even as something conducive to the *Bildung* of the author) already depends on one conceding that *techné* has a place in science (and *Bildung*).

The arguments presented in this work aim to show that one should. It is thereby possible that the concept of *Bildung* will thus lose that dignity which, for many, renders it both attractive and exclusive as opposed to "mere accumulative learning". Not simply because, as a consequence, learning experiences a re-evaluation over and against *Bildung*, but also, and above all, because *techné* in its pragmatic, evasive character is deeply profane, almost antiheroic. "May I never have a character like that, but walk in straightforward ways", wrote Pindar accordingly, in view of Odysseus' ruses (taken from Neiman 2008, p. 310).

I will begin again[1] in the laboratory. Just as Latour holds the results of scientific and technical research[2] in the philosophy of science to be the Archimedean pivot upon which it would be, or—if one is optimistic—upon which it has become possible to lever[3] sociology from out of its forgetfulness of the material, I also assume that the results of contemporary scientific and technical research in the philosophy of science can be used in the same way as an Archimedean pivot for the theory of *Bildung*.

In the laboratory the meaning of technology for "fundamental changes in the figures of the relationships to the self and to the world" (this is at least undisputed with reference to relationships to the world) is so obvious, as well as being so well empirically researched—and, thanks to the laboratory scientist's good documentation, is itself accessible to research—that it offers the possibility of testing theories for their ability to reflect processes of world disclosure together with technology in a fundamental manner.

The laboratory can thus, in a sense, serve as a laboratory for researching *Bildung*. This is because that which proves itself in a laboratory must also be transferable to those locations where the relevance of technology to fundamental changes in relationships to the self and the world is not so apparent and so theoretically easier to *pass over*. If one bears in mind that, in general, technology is developed as a means towards achieving a certain goal without the technology coming overly to the fore,

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[1] In Ahrens 2005 I cursorily present the significance of contemporary scientific and technical research with respect to an educational-theoretical debate with the natural sciences and technology. I draw upon that work here, whereby the repetition of certain aspects is unavoidable where they are fundamental for the ensuing arguments. It should become clear in the following that such a new approach can also have a methodological-strategic significance. For formal reasons it is here noted that it is not a question, not even partially, of a simple repetition—namely insofar that these aspects, are now revised as recontextualised, decisive aspects of the former line of argumentation.

[2] For an overview cf. Biagioli 1999.

[3] Cf. especially Latour 2005, p. 98, where, in addition to this, he emphasises under the aptly coined title *The fortunate wreck of sociology of science*, that the laboratory studies are more than just an impulse, but rather constitute a field of sociological research of lasting value. Cf. also ibid., p. 119.

i.e., it is developed in order to be forgotten, then this means as good as nearly everywhere. In Latour's words:

> Scientific practice is the drosophila of social theory since it offers an exaggerated and scaled up version of what can later be studied in much more inaccessible domains. […] Compared to other domains, science is easier because the debates about the detours of objectivity are much more traceable. (Latour 2005, p. 119)

According to Latour, it is thanks to the natural sciences themselves that the sociological research of science has not been able to conceptually ignore the participation of technological and epistemic things (see Sect. 3.6 for an account of these concepts) in the knowledge acquisition process in their work in the laboratory. The natural sciences have strongly protested against the classical sociological manner in which they have been described, and have so shown the sociologists where they have inexplicitly (or even explicitly—even that has actually happened) declared the *explanandum* "social" to be the *explanans*.[4]

The experiment of this work, which is prepared by returning to the laboratory to begin again, is bound to the risk of repetition. The danger of a mere repetition is the danger that one can never exclude when experimenting, because one can do nothing other than repeat when one experiments. However, the aim consists of avoiding *simple* repetition and, through the deviation from the ideality of a simple repetition, enabling the new to make a difference. This is an attempt at the strategic use of iterability, an approach which will be introduced as an important characteristic of the experimental itself (see Sect. 3.2). Nevertheless, nothing has been won yet, apart from the knowledge that there is a fissure between the repetition and the repeated, between the intention and the intended action[5]—even if intention means nothing other than that in an action that differentiates it from mere behaviour.[6]

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[4] "Chemist, rocket scientist, and physicists are used to seeing their laboratories explode, but it had been quite a while before the sociologist's office could run an experiment risky enough even to have a chance to fail! And, this time, it did explode." (Latour 2005, p. 99) What Latour so aptly describes is above all the debate in the scientific community regarding "social construction". (Cf. Hacking 1999 for a summary of this).

[5] The most consequent account of intention can be found in Husserl. According to Husserl, aiming for something non-intentional can only be described as a paradox. Insofar as consciousness for Husserl must always target something—that is exactly what intentionality describes—so consciousness is always a consciousness of something, or an act always deals with something, in this strict sense intentionality includes the non-intentional, it is the same as "a universal medium […], that eventually carries within it all experience, even that which is not characterised as being intentional" (Husserl 1950/1913, p. 171 my trans.). For Husserl intentionality has a transcendental status of total comprehensiveness: "Intentionality is the name of the problem encompassed by the whole of phenomenology. The name precisely expresses the fundamental property of consciousness; all phenomenological problems, even the hyletic ones, find a place within it. As a consequence, phenomenology begins with problems of intentionality" (Husserl 1982/1913, p. 357). On the other hand, Adorno for example, refers to the inconsequent usage of the concept of intentionality by Husserl, which on the one hand admittedly "should include all cogitationes", but, on the other hand, distinguishes itself from those "sensual" experiences or sensory content that he terms "primary content". (Adorno 1973, p. 68). For the theoretical consequences of such a comprehensive concept shown in the example of "World" compare Chaps. 8 and 9 in this section.

[6] This would correspond to Luhmann's concept of intention. In contrast to Husserl's transcendental solution for intentionality, Luhmann displaces intention within the immanence of the social

Thus, nothing is won by simply renaming repetition as iteration. More precisely, nothing will be gained until one not only insists upon the difference between a differentiation enabling repetition and a differentiation hindering repetition, but also makes the effort to enquire *what* the difference is between these two forms of repetition.

The difficulty lies in the fact that the difference around which this centres cannot be intentionally produced as the interesting point of an experiment, is that which reveals *itself*, and not that that *one* reveals, and certainly not that *at which* one points. However, the following should make clear that that does not mean not being able to do anything.

2.2 The Concept of the Experiment

> The experimenter will not be surprised by the result of his work
>
> —Gunhild Berg[7]

It is said that there is a boom in the concept of the experiment. And this boom is by no means limited only to a certain scientific community. In a recently published volume on the history of science understood in terms of a history of ideas, Gunhild Berg speaks of a simultaneous "boom of the concept 'experiment' in the natural, social and humanistic sciences" (Berg 2009 my translation).

Berg holds this to be so extreme that "only the concept of 'knowledge', including its derivatives and composites" (ibid., p. 51) is able to compete with the vogue of the concept of the experiment. I share this view at least to the extent that I assume that the concept of the experiment has gained significance in a striking manner and appears to exude a certain attraction upon various authors.[8]

However, contrary to Berg, I also assume that there are good reasons for this. A conceptual-historical analysis is not necessary to gain an initial impression wherein its function—at least with respect to the theory of *Bildung*—could reside. A cursory glance in a few publications in the field of contemporary theory of *Bildung*, in which the experiment concept has found coinage, is sufficient.

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and replaces the last level of allocation always with the last but one observer. Luhmann accounts for intention as a necessary transferral fiction with which one can accord acts to persons. Non-intentional acts are as such not possible, rather they are termed behaviour. (Luhmann 1992c).

[7] This quotation is taken from a preliminary version of the 2009 essay, the final version of which will be discussed in the following. In the final version the formulation is slightly defused to "the experimenter will *seldom* be surprised by the result of his work" (Berg 2009 p. 57, my emphasis). However, this changes nothing in Berg's argument that the experimenter tries to avoid surprises as this would mean "simply the failure of the attempt" (ibid.). The preliminary version can be found under: http://www.zfl.gwz-berlin.de/fileadmin/bilder/Projekte/Begriffsgeschichte/Berg_Konjunktur_Experimentbegriff.pdf.

[8] For want of reliable research regarding the use of the concept this impression can only serve as circumstantial evidence, which is also why the following arguments do not build upon it, but rather conversely aim to clarify the concept's attraction from that matter at hand and so render the (possibly) increased usage plausible. Berg himself refers to a quantative study regarding the use of the concept by Jörg Armin Kranzhoff in 1965.

Even only a few examples already make clear that the concept of the experiment (sometimes in quotation marks, sometimes not), without it in each case being too deeply explicated, with respect to various authors and, in each case, with different theoretical contexts, is almost always used in a structurally comparable problem—admittedly mainly as a demarcation rather than a solution to that problem.

Thus the concept of the experiment is often used as a kind of limiting concept, which inhabits the margins of the possible and frequently finds itself exactly where paradox obtains a practical meaning and can be taken to be just as practical a challenge.

And so the concept of the experiment comes to play in Jenny Lüders' educational-theoretical reading of Foucault exactly there where the experience of one's boundaries approaches the boundaries of the very possibilities of one's experience. It comes into play in the practical impossibility of extending one's possibilities from outside of one's own possibilities (Lüders 2007).[9]

Starting with the question as to how critique in Foucault's sense can be thought practically, Lüders implements Foucault's concept of critique so consequently that its paradoxical nature becomes apparent. Contrary to what is still common in contemporary reception of Foucault, she refuses to defuse the challenge presented by Foucault's thought by playing down the concept of critique to a "we-know-better" knowledge about present power relations so that one can erroneously imagine oneself occupying an "enlightened" position in a manageable distance to them. Rather, she emphasises the inability to step out of the power relations constitutive of the subject as some kind of sovereign supra-subject in order to be able to change oneself from an external position.

If a determined perspective is absent, and the conditions for changing the power relations constitutive of the subject can themselves only be situated within this, then, according to Lüders, following Foucault, one can do nothing other than attempt to change the boundaries of the possible *experimentally* (cf. Lüders 2007, p. 118). Here, she succeeds in salvaging the double meaning of the French *expérience* as experience and experiment[10] in German: "It concerns the convergence of one's own being in its total conditionality. But, because I am unable to grasp these conditions in their totality I must experimentally test them, strategically approach them, and provisionally think them in another way in order to render them as contingently experiential within this 'other' thought. And it is precisely in this attempt to 'critically' grasp the borders and conditions of one's own being that they are possibly dislocated." (Ibid.).

As such, understood as it is here, as a characteristic of a critique that has turned practical, the experimental is not a concept that attracts greater attention in Lüders' argumentation, and also receives no closer determination either by her, or by Foucault himself. However, one can ascertain that *Bildung*, as determined by Lüders, is dependent upon experimentation.

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[9] We are not concerned here with discussing of the "concept of the experiment" in each and every author, but rather solely with collecting indices of its virulent function in educational theory.

[10] Cf. also Stengers 2008.

Another example of the application of the concept of experiment in contemporary educational-theoretical publications can be found in two essays in the recent collection "Bildende Widerstände—widerständige Bildung"[11] (Thompson and Weiss 2008). Roswitha Lehmann-Rommel, who also refers to the connection between experience and experiment, holds that the "experimental thought" of both Kant and Dewey, which she differentiates from a "technical understanding of 'experiment'" (Lehmann-Rommel 2008 p. 121), offers an alternative to the epistemological model of representation. The concept of experiment serves as a delimiting concept in her work too.

Starting with Kant's demand for firstly creating "experimental schools", and then "normal schools", formulated in his lectures on pedagogy, she reconstructs the experimental moment in Kant as the interface between reason and practical knowledge. For him, experimentation marks "the point of contact between human conditionality as a being of sensory perception and rationally accordant freedom of creativity in each respectively discovered world" (ibid., p. 125). As reason alone is unable to overcome the limitations of the educator in his own development, at that time he conceives *Bildung* as an intra-generational project of the Enlightenment. And, since reason alone is also not able to "judge how reality can be formed according to principles" (ibid., p. 124), experimentation, as an "empirical business, open to the future" is necessary, which itself "can be obtained neither through the accumulation of practical knowledge nor through theoretical reasoning and planning" (ibid.).

Dewey's "Logic of Inquiry" can be understood as being no less related to practical knowledge and no less oriented towards a transgression of the limitations delivered by one's own access to the world within the simultaneous impossibility of external guidance. With Dewey, experimentation aims for the "emancipation from the rule of habit" (ibid., p. 135, emphasised). Interestingly, experimentation is not here associated with science itself, but is rather, on the contrary, understood as a philosophical praxis which has as its object the critique of the tendency of the natural and social sciences to continue treading their well worn paths.

Thus, Lehmann-Rommel sees the decisive characteristic of experimental thought in Dewey correspondingly:

> That in an experimental operation nothing is fixed—neither the leading idea, the conclusions and judgements, nor the observed or supposed nature of the object. Ideas control only always on a trial basis; their acceptance strictly depends upon the results of the experimental operation. This is always specific to the situation and cannot fall back untested on any authority drawn from earlier findings. (Ibid., p. 130)

In the same volume, Gabriele Weiss is also concerned with working at the limits of one's own possibilities: while, in relation to the paradoxically posed question: "How can one see otherwise than one sees?" she explicitly engages with Ludwik Fleck's description of the experiment in natural science and his account of how that which is new originates, she reads Humboldt, without mentioning the concept of

[11] [Translator's note] "Formational Resistances—resistant Education"—in the German the title plays on the double meanings of Bildung as formation, and as formal education.

the experiment itself, as a theorist who attempts to answer the equally paradoxical question: "How can one speak otherwise than one speaks?" (Weiss 2008).

Admittedly, she does not use the concept of the experiment here, but there is a structurally comparable problem that she sees addressed by Humboldt which allows her to draw him into a relationship with Fleck: for Humboldt too, the changes focussed upon here cannot be initiated externally (to language); it is rather much more a question of transforming and remodelling language.

Thus, despite the differences in the details of their respective approaches and the futility of determining the concept of the experiment beginning with their work, it is all the more clearer that the concept of the experiment cannot be awarded an arbitrary function in their respective works: it is characteristic of a praxis on the margins of one's own possibilities, where paradox becomes practical.

The supposition that the concept of the experiment is a non-arbitrary function operating at the limits of possibility should be sufficient to distance ourselves from Berg's speculation that the "conjuncture of the concept of the experiment" can be explained by the use of dubious means in a fight for recognition, which she describes in Bourdieu's vocabulary as a symbolic struggle on the social field of the sciences.[12]

This is namely a struggle in which the social scientist attempts to win points through "the frequent use of a semantically diffuse concept of experimentation" (Berg 2009, p. 69 ff.) and so, in a certain way, parasitically profits from the dignity of the natural sciences. She writes: "It appears as if the social sciences [humanities], by taking a share in the concept (irrespective of whether via definition, use, methodology etc.) are fighting for their entitlement to participate in the socially respected and award winning (natural) scientific discourse." (Ibid., p. 70).

Berg thinks that the concept of experiment used in the humanities and social sciences is semantically diffuse insofar as it concerns an inappropriate and basically purely metaphorical transfer of a specific concept belonging to the natural sciences. The suspicion that social scientists (and their humanities counterparts) would try to symbolically increase the value of the perceived deficit in their scientific scholarship through pilfering vocabulary from the natural sciences is, in its general culturalised form, nothing new; one is confronted with this phenomenon in various disciplines (and in various forms) but above all under the catchphrase "physics envy". So Giddens, for example, already wrote in the seventies:

> a sort of yearning for the arrival of a social scientific Newton remains common enough, even if today there are perhaps many more who are sceptical of such a possibility than those who still cherish the hope. But those who still wait for a Newton are not only waiting for a train that will not arrive, they are in the wrong station altogether. (Giddens 1976, p. 13; but also cf. Munger 1995)

According to Berg the particular problem with the concept of experimentation consists in its metaphoricity and its origin in the natural sciences, from which the concept cannot be easily transferred to less exact sciences. A multitude of usages additionally undermines its usefulness. Thus, on the whole, the concept gains in

[12] Cf. above all Bourdieu 1988.

popularity less from its usefulness as much more from the appearance of scientific scholarship that can still be maintained after its import from the natural sciences even as a semantic corona to some extent plays over its real lack of content.

And this suspicion of motives is not without its grounds: Berg relates various examples of highly inappropriate dealings with the concept of experimentation, dealings which really are based upon an inappropriate transfer of a concept of experimentation drawn from the natural sciences, so that these examples convey the impression that the concept of experimentation, as used in this way, is almost completely enveloped by its strategic significance.

However, this suspicion of motives disguises the more interesting and important question: whether there could be other, more objective reasons for the increasing attractiveness of the concept of experimentation. The speculation[13] that this is indeed so guides this work. The view that there are good grounds is reason enough not only to use the concept of experimentation frequently, (thereby arousing the suspicion of questionable motives), but also, for purely humanistic reasons, to completely orientate oneself according to the experiments of the natural scientist.

Nevertheless: according to the experiments themselves and not the "definitions of the experiment put forward by natural science" or the natural scientist's "concept of experimentation" upon which Berg concentrated, and then appeared to equivocate with the praxis of experimentation: this embraces "since early modernity, apart from its explorative function also its verificational, evidential and demonstrative functions." (Berg 2009, p. 52).

An initial practical indication as to why the relation of the humanities and the social sciences to the concept of experimentation is almost always inadequate is thus given by Berg herself: namely, she refers to an equally common as inappropriate "natural scientific concept of experimentation", that, as a matter of fact, (and this is to be shown in the following), can neither be understood as explorative nor correctly characterised in terms of the functions of verification, evidence or demonstration, and not once in terms of the function of falsification.

Just because many experimenters appear to believe in this definition does not make it true. One of the early findings of the philosophy of science was that there is a difference between that which the experimenter does, and that which they s/he believes him/herself to be doing when s/he reflects upon his/her work (a significant problem for propaedeutics, insofar as it also orientates itself according to a theoretically plausible, but nonetheless inaccurate, picture of science). Accordingly, the problem for the philosophy of science has always consisted in the fact there was no-one available whom one could, in a certain sense, by way of an expert interview, simply ask. Gaston Bachelard brought this to a head when he turned to natural scientific experimenters and demanded of them:

> Tell us what you are thinking, not as you *leave* the laboratory, but during those hours when you quit ordinary life to *enter* scientific life. Give us, not the empiricisms of your evenings, but the vigorous rationalism of your mornings, the *a priori* of your mathematical dreaming, the urge behind your projects, your unadmitted intuitions. (Bachelard 1968, p. 11)

[13] One could, with respect to Sect. 3.13, also talk of intuition.

Thus, in order to demonstrate the inappropriateness of the human sciences' dealings with the concept of experimentation Berg paints a picture of the natural scientific experiment which the human sciences indeed do not match and cannot match, but which is repeatedly striven for.

However, this picture *cannot* be matched by either side—neither that of the human sciences nor that of the natural sciences, which is why the problem of the increased usage of the concept of experimentation does not consist in its erroneous transfer from the natural sciences, but rather much more fundamentally in *a continuing lack of understanding of the experiment itself*.

The picture of the experiment drawn by Berg is equally widespread as it is inaccurate; but it is not simply inaccurate: rather, that attempt to empirically match each single characteristic of the concept of experimentation, which itself is not further problematised by her, introduced by her into the field, would render every natural (as well) scientific experimental research impossible (insofar as we are still dealing with research in the strict sense, namely the generation of new insights). She writes: Insofar as the "modern social sciences" define the "'experiment' under the explicit reference to the natural sciences as an instrument for the validation of previous theoretical formations, and as an instrument of knowledge propagation along the lines of a proto-theoretical experience" they orientate themselves according to "the paradigmatic conceptual understanding of the modern natural sciences" (Berg 2009, p. 53).

It is the concept of the experiment in natural science that "since early modernity, [has] apart from its explorative function also [embraced] its verificational, evidential and demonstrative functions." Berg thinks that the literary and cultural studies have now confused the creative aspect of art production with the "explorative [aspect] in [the natural scientific] experiment" that "segments and isolates a slice of reality" which stands in opposition to "free formation" (ibid., p. 54 ff.). The fashion of understanding[14] the essay as an experiment in writing suggests "a tendency toward open-endedness common to both forms" that, however, in the face of a necessary meeting of "assumptions about the course and results of experimentation" thwarts the very idea of open-endedness in the natural sciences and allows "in each case, uncertainty about the results of an experiment", assumptions that the natural scientist would "express as experimental planning and ordering". As a consequence, an "unexpected result […] would simply mean a failed attempt for the natural scientist, namely the disappointment of his/her expectations" (ibid., p. 56).

If the experimenter is actually not, or only seldom, surprised by the results of his work in this sense (i.e. in the cases representing "simply a failed attempt"), then the experiment understood in its "strict" natural scientific form could not represent a strategy for gaining knowledge, at the most, it could be an aid toward testing the reality content of results already won.

And it is exactly as such an agent for the purposes of falsification that the natural scientific experiment is still understood, which is also why it has, until now, only been misunderstood, or could only "metaphorically" fertilize discussions about

[14] A fashion, by the way, that I also follow: cf. Sect. 4.7.

knowledge and *Bildung* and can certainly not be understood in terms of its appeal as an especially analysable expression of a *general* form of knowledge, which should be here termed experimental.

The experimental way of winning knowledge is admittedly not "the only way that we can learn", as Lehmann-Rommel writes in her dispute with Dewey (2008. p. 129). But it is also not simply just a natural scientific method for which there was no equivalent outside of the narrowly defined area of the "experimental natural sciences". That the experiment is not,[15] and cannot be, a method at all (and certainly not a tool: cf. Sect. 3.7) is what allows the concept of the experiment to be related to the theory of *Bildung* in the first instance.

That the experiment is not a method is also valid for the natural scientific experiment itself, and it is never simply an "exact" method; or a method completely subdued to rationality as, for example, Max Weber appears to envision when he speaks of the "the great instrument of scientific work" that represents "the rational experiment, as a means of controlling experience reliably" (Weber 2012/1922, p. 343).

However, on the other side of the coin, the experiment is also not a free, playful event. It would be a fundamental misunderstanding if one understood it to be a term of convenience, as so often happens in reviews of bad or misunderstood art where the expression "experimental work" is nothing more than a polite focussing on the trial and error nature of the creative process in order to avoid having to say: *that* result could not have been intended. But if experimentation is neither a method nor a free, playful affair it is certainly a kind of strategy for discovery, or, more precisely: a demanding and targeted form of world disclosure, characterised by the absence of an intentionally pursued aim.[16]

And it is one which finds its complementary form of world disclosure in exploration.[17] The concept of exploration is seldom thought in the strict sense as the antonym of experiment; generally one finds the experiment as a hyponym, as a subcategory of exploration.[18]

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[15] The absence of a specific methodological process in the laboratory has been proven by Latour and Woolgar 1986/1979, Knorr-Cetina 1981 and Lynch 1985.

[16] For the concepts recognition, world disclosure and knowledge see the first footnote in Sect. 2.7.

[17] A comparable idea can also be found in Deleuze and Guattari, who oppositionally present two kinds of scientific work which, on face value, appear to correspond to the following differentiation made here between experiment and exploration, but on closer reading is not compatible with this and is, in fact, in opposition to it. They write in *A Thousand Plateaus*: "A distinction must be made between two types of science, or scientific- procedures: one consists in 'reproducing', the other in 'following'. The first involves reproduction, iteration and reiteration; the other, involving itineration, is the sum of the itinerant, ambulant sciences. Itineration is too readily reduced to a modality of technology, or of the application and verification of science. But this is not the case: following is not at all the same thing as reproducing, and one never follows in order to reproduce" (Deleuze and Guattari 2004, p. 410). It becomes clear how this difference is incompatible with that put forward in this work in the concepts of iteration, reproduction and repetition. (Sect. 3.2).

[18] Repeated in e.g. the conference "The Man in the Experiment, 1850–1980" from 22.05.2008 to 24.05.2008 in Berlin. Cf. Volker Hess' contribution in the daily protocol: H-Soz-u-Kult, 02.08.2008, <http://hsozkult.geschichte.hu-berlin.de/tagungsberichte/id=2209> (As of 22.3.10).

In this sense, "exploration" stands for the general concept of research and the experiment is seen as a specific method of scientific exploration.[19] If *Bildung* is, as posited by this thesis, nothing other than the experimental form of world disclosure as applied to the individual, then learning, as the explorative form of world disclosure as applied to the individual, is, in an equally rigorous sense, its complementary antonym.

Thus if, in the following, we talk of experiment, then not by distancing ourselves from its "stricter", natural scientific form and merely metaphorically relating to it, or by claiming that it is equivalent to the "free", "playful" and creative method of the "experimental" artist, but rather by attempting to think it in its most rigorous form possible, sharpened, if you will, on the "hardness" of the natural sciences.[20] I see no other possibility of arriving at a useful, not simply derived, concept of the experiment, which is not confined to the natural sciences than through the most precise possible understanding of the natural scientific experiment itself.

The inevitable distinction between the natural and human sciences will not be abolished by this, but decisively reconfigured. The question as to how one can distinguish between the natural and human sciences should not be pursued here; it is also no longer particularly interesting if one no longer assumes a categorical distinction. At this stage it suffices to say that the difference between the experimental in the natural sciences and the experimental beyond the natural sciences certainly does not consist in one case involving technology, and the other not. Rheinberger clearly states: "*All* experimentation is technically implemented" (1997, p. 141).

Similarly, the difference does not consist therein that in the one case the talk is of *Bildung*, and in the other, not. Here it is sufficient—in anticipation of the argument—to assume that there are educational processes and that these can only be described experimentally (in both possible senses of this sentence: cf. Sect. 4.8).

If one wishes to investigate the significance of technology in the experimental processes of world disclosure then it seems to be obvious that one must find success in the natural sciences as their entanglement with technology is evident. This, however, is not the case. Almost the entirety of the philosophy of science in the tradition of the Vienna Circle[21] has succeeded not only to deny the value of experimental *process*, but has also managed to largely ignore the technology involved (including their medial character for discovery).

Achieving this is not some form of omission, but rather requires a considerable amount of theoretical effort. The will to such an attempt can only be retrospectively explained by the predominance of a system of thought (see Sect. 3.23). This makes an appearance with a claim to undivided validity and is so stamped by the

[19] This is even valid where the experiment is no longer misunderstood as a tool for exploration but rather recognised in its own right and not reductionally understood. As in, for example, Friedrich Steinle, who talks of explorative experimentation when he describes the "diversity of experimental experience" (2000).

[20] Whereby the converse can be said to be true, that such art commonly designated "experimental" is, in reality, seldom experimental, whereas truly experimental art is anything but free, playful and "creative". Cf. Ahrens 2009 which touches on this theme using the example of cinema.

[21] Regarding the distinction between the scientific theory of the "Tradition of the Vienna Circle" and of the "Lwówerian Tradition" cf. Ahrens 2005, esp. Chap. 3 and the cursory points here in Sect. 4.7.

exploratory (a form of world disclosure where technology can actually be more or less ignored) that its complementary opposition, the experimental, can hardly be recognised as an independent form of world disclosure. This is also why it should be termed the "explorative system of thought". If it was no longer possible in the natural sciences to think of the participation of technology in experimental processes despite its obvious indispensability then this is all the more valid with regards to the experimental beyond natural science.

2.3 The Experiment in an Undivided World

One of the most astonishing phenomena concerning the experiment is the ease with which it is taken to be a legitimate and trustworthy source of truth while it remains simultaneously decidedly misunderstood—above all with respect to the knowledge conditioning role of the technology involved and its meaning which stretches far beyond the natural sciences.

However, this phenomenon only comes into focus when one considers the *experimental* not only as a theoretical model and the distinction between exploration and experiment not only as purely analytical, but rather by actually taking it seriously as an empirical fact. Here there should be, corresponding to the measure of confidence placed in the experiment, a willingness to use experimental results and findings as the basis for consequential decisions and not just some externally imported epistemological doubts.

Insofar as everyday life is filled with technological things, the existence of which can be attributed to experimentally won knowledge, then this confidence is itself not something added on reflection, but rather the never fully present reflexive precondition for participation in present, everyday life. This simultaneity of incomprehension and self-evidentiality is indeed self-justified and, on the one hand, still affects the function of the experiment itself and, on the other hand, is so far reaching in its meaning that it configures the relationship between experiment and technology and thus enables us, at *theoretically decisive points*, to talk of the experiment and the necessity of the experimental, without it in any way being necessary to relate what is here to be understood and how one is to envisage it.

That one *can* experiment, and that experiments *happen* appears to legitimise the use of the concept of experiment in a similar fashion to the confidence in experimentally obtained results. The misunderstanding of the experiment goes so far that a whole research industry has been erected around it, with the aim of understanding it. And it is so closely bound with it that the newer research into science and technology can loudly trumpet, as genuine knowledge, the discovery of the experiment as a generative centre of knowledge production centuries after its invention.

To now attribute this misunderstanding to a mere indifference or even to people's stupidity[22] would itself be based upon a decisive misunderstanding of the

[22] Stupidity in the sense of a lack of judgement as Kant defines it in the Critique of Pure Reason (A 135/B 174 in original). This clearly does not involve a lack of judgement. Cf. also with reference to this Geisenhanslücke 2009.

functioning of the experiment. The possibility of being able to forget the functioning of the experiment, and with it the fact that the technology involved plays a fundamental and not simply a secondary role, is both the aim of a scientific experiment as well as an indication of its success, so that the simultaneity of this will-not-be-understood and the widespread trust in its functionality are the best indication and the best evidence of its comprehensive success.[23]

Experimental science only gains momentum initially from the systematic inclusion of this misunderstanding. This success is neither a given nor is it unconditional, it had to be laboriously fought for.

From today's perspective, the trust placed in the experiment as a legitimate form of accruing knowledge and discoveries without actually understanding it (which includes even the experimenters themselves) is the reason why those who principally trust the functioning of the experimental method (which, as has been said, means the same as participating in everyday life) do not today appear to be stupid; this is rather saved for those who are *indifferent* to the results of experiments. Today, for example, it is the eighteenth century British Navy that appears stupid when it ignored an experimental study as to how to prevent scurvy through the consumption of citrus fruits for a full 48 years long;[24] an ignorance, which is much more than just a footnote in the history of the experiment, that cost more sailors' lives than caused by all the acts of war put together in that same period in which an act of war was hardly a rarity.

Scurvy is in a sense the deadly shadow of classical exploration that accompanied it since the beginning of its heyday, starting with Columbus' travels and was only first shaken off with the acceptance of the experiment as a legitimate form of acquiring knowledge.

Today it is difficult to see how one can ignore research in which the solution to an urgent problem is described in clear, comprehensible and credible language,[25] a problem not only regarding life and death, but rather, as one can see in retrospect, the whole national state system of Europe; research which described, step by step, how scurvy sufferers were systematically treated with various means and showed that it was those, and only those, who had drunk citrus fruit juice were the ones almost completely healed after a short time, while the flesh fouled on the porous bones of the others, and, point for point, demonstrated that those ships' crews provided with lemon juice remained totally free of all symptoms, while everywhere else one man after the next was thrown overboard.

It was not that the research was unknown and simply overlooked—it was published, appeared in large numbers and was obviously discussed (cf. Carpenter 1987,

[23] This will be further explored below. At this stage it will only be indicated that this is not a rhetorically exaggerated account for the sake of a punch line, but rather an account striving for the correct representation of the functionality of the experiment with an accordingly comprehensive claim to validity.

[24] The study by James Lind: *The Health of Seamen* (Lind 1965) is here referred to.

[25] Not only from today's perspective: even then it was neither misunderstood nor was the author accused of intending to deceive. On Lind's reception in connection with the history of scurvy and the discovery of vitamin C, cf. Carpenter 1986.

p. 51 ff.), even if it was only after the death of its author, James Lind, that it became *the* study of scurvy, and Lind himself was declared the exemplary methodologist of medicinal-experimental research. The reason for this ignorance could be found much more in the insufficient exclusivity of a research community, which would have allowed the experiment to be a success from a social point of view (it remains to be demonstrated that an experiment is only successful when it succeeds in both technical and social terms) and that which one could term the persistence of explorative thought (cf. Sect. 4.5).

In a sense, the British Navy found itself still in the pre-experimental stage, just as exploration dominated the whole of field of rationality, and the scientific world had not yet been divided [*Teilung*][26] into a world through experimenting on the world.[27] As long as the "world of the sciences" was not yet itself divided [*Teilung*], and exploration dominated the whole field of rationality, the sector of the scientific world which would first allow experimental discoveries to be recognized as discoveries was lacking. Thus, every discovery understood as being explorative in nature, also became equivalent with the claim for the discovery of an undivided world.

There were many other studies of scurvy in Lind's time, in which the healing powers of all possible remedies were demonstrated—and, in part, from highly ranked (i.e. trustworthy) military whose areas of expertise, which included the well-being of their sailors, were accorded much more attention.[28] Analogous to this, most studies lacked a clear division [*Teilung*] of the world of scurvy from the rest of the sick world so that a lack of vitamin C had no chance of making itself be known among the rush of symptoms arising from malnutrition, overwork, infections, epidemics and an absence of hygiene.

The situation of experimental medicine thus resembled a large part, if not the whole of science, before its constitution as an autonomous entity through communities such as the British Royal Society: the scientific community was not yet a closed entity in opposition to the world outside, it was not yet exclusive enough, so that the world had little reason to open up toward it.

That is the principle of expertise seen from the perspective of the expert: one must first persuade the others that they have nothing valid to say on a subject, that they stand outside, before it is worth speaking to them; for, as long as the world

[26] [*Teilung* in German always carries both the sense of sharing and of dividing, much like the old arithmetic sense of share in English. I will remind the reader of this by placing it in the text.—trans.].

[27] On the division of the world see part 7 in this section.

[28] "Dozens of tracts were written on scurvy, claiming such varied causes for the distemper as foul vapours, dampness and cold, an excess of black bile, laziness, copper poisoning, the Dutch method of refining salt, inherited predisposition, blocked perspiration, and divine disfavour. […] Typical cures included purging with salt water, bleeding, eating sulphuric acid or vinegar, smearing mercury paste onto open sores, or increasing sailors' workload in the belief that the disease was caused by indolence and sloth." (Brown 2004, pp. 10 ff.) Even citrus fruits themselves were suspected of causing symptoms of the disease; in 1712 a John White speculated "that fresh fruit was a direct cause of enteritis, inflammation of the small intestine, and that one must, when ships reach countries abounding in oranges, lemons, pineapples etc., ensure that the crew eat very little of them since they are the commonest cause of fevers and obstruction of the vital organs" (ibid., p. 50).

thinks that it has something to say, then it will simply not listen. This ambiguous matter of fact is, by the way, nowadays regularly forgotten when an education in natural science is equivocated with a "critical" appreciation of scientific fact.[29]

How little trust had been established in the experiment and its results, and above all, how little established the context of research was in which results could be determined as knowledge, and so become the starting point and standard for future research, is best illustrated by the following fact. Lind himself, despite this exemplary, empirically rich study with its clear results, despite all the methodological arguments he presented in what was initially meant to be an article in a journal, but turned out to be a 400 page book, at some stage, without necessity, gave up on the idea of the citrus fruit and subsequently turned to other ideas for preventing scurvy.

This went so far that, in the third edition of this study—utterly without experimental proof, and, from today's perspective, quite surprisingly—it was found that scurvy could be prevented by regularly imbibing sufficient quantities of beer. It was a year after Lind's death that lemon juice became a part of the standard inventory in the British Navy and in a single stroke achieved a decisive and, in view of the substantial death rate attributed to scurvy, easily comprehensible strategic advantage.

So the lowly lemon, this rarely appreciated historical player, warranted the subsequent predominance of the British at sea for decades afterward and prepared Napoleon's downfall by aiding their victory in battle of Trafalgar (cf. Brown 2004).

2.4 The Invention of the Experiment

> Thus it is he [the theoretician] who shows the experimenter the way. But even the experimenter is not in the main engaged in making exact observations; his work, too, is largely of a theoretical kind. Theory dominates the experimental work from its initial planning up to the finishing touches in the laboratory.
>
> —Karl R. Popper 1972, p. 107

In order to be able to understand the particularities of the experiment, the reasons for overlooking it as a generative centre of knowledge production and thus also the reasons for overlooking technology as an irreducible medium of knowledge—all reasons that should ultimately shed light upon the theory of *Bildung's* technological amnesia—, beginning right from the start is inevitable, namely with the invention of the experiment and the reflection of its contingent conditions of possibility from this vantage point.

If one follows the narrative provided by the science historians Shapin and Schaffer, then this begins with Robert Boyle and the early days of the British Royal Society. If we then consider the date of Lind's failure, namely many years after Boyle, and the fact that Lind presents just one example among countless other failed or successful experimenters, then the longevity of the processes of differentiation and establishment of this form of knowledge acquisition becomes apparent. And it is

[29] Cf. Sect. 4.6 on this.

perhaps in this light that the continuing delay with which its significance in scientific and epistemological discourse came to be adequately reflected, and has only just recently been discovered as decisive in theories of *Bildung*, can be clarified.

Looking at the beginnings of experimental science also means looking at the points of decisions that have determined the direction in which contemporary histories of science can operate. In the naive historical narratives of science, which do not reflect these decision points, Boyle is seen as the one who, in addition to a few other important things, proved the existence of air pressure.

This historical narrative of science is naive because it views Boyle *ex post*, working under conditions which were first constituted and stabilised after him, and with the help of his air pump. Boyle himself had to ensure that the results of his experiments could attain the form of a generally valid truth, a task which today can be understood as part of an always already divided [*geteilte*] world, namely a division [*Teilung*] which enables people to share [*teilen*] a world with facts that contradict both their knowledge and their experience.

For example, accepting that it is possible to create a vacuum, a space in which there is nothing, is not a given; at least for as long as truth depends upon understanding. After all, went the arguments at that time, there must be something there because it is obvious that at least light is passed through, and it makes no sense logically to say *that nothing transmits*.[30]

In order to achieve this, Boyle had to make sure that certain, especially chosen gentlemen who were present as witnesses to the experiment were able to make statements that carried more weight than the word of a mere individual, even of the crown sovereign or the blessed common sense of the people; and, in addition to this, he had to ensure that the results were not only valid in the space of the bell jar, but were valid for the whole world and for all time. And one does not undertake something like this lightly: "the experimental production of matters of fact involved an immense amount of labour, in that it rested upon the acceptance or rejection of certain social and discursive conventions, and that it depended upon the production and protection of a special form of social organisation" (Shapin and Schaffer 1985, p. 22).

Boyle was neither able to grant his results validity in the dominant epistemological discourse, nor could he simply erect new criteria for the truth. His art, which is nothing other than experimental (an experiment before the experiment),[31] consisted

[30] It belongs to one of the ironies of the history of science that the acceptance of Boyle's truth, that one can create a vacuum, has established a tradition in which it is today possible to say: "We know that that is impossible. An absolutely empty space does not exist." (Genz 1994, p. 256) It is rather "all full of swarms" (ibid., p. 224). Also see Genz 1994 for an overview of the history of the vacuum and the possibility and impossibility of thinking it. Opposed to this, Carl Friedrich von Weizsäcker has said in an interview: "The vacuum is the whole" (quoted from Görnitz 2010). It is as if the universe itself was the result of a re-entry and thus simply existed as the temporalised form of the paradox of consisting of matter and non-matter.

[31] It remains to be shown that this is not a logical confusion but rather the translation of a general experimental principle in scientific discourse.

of assembling recognized and proven techniques in a novel way and, in this recombination, creating something new from the old.

Essentially, Boyle used three techniques to set his experiments apart from the backroom experiments of the contemporary alchemists, who were also all proving something and claiming validity for their finds. These were: firstly, an admittedly difficult, but nonetheless reproducible material technology with which the conditions could be created that allowed the demonstration of that which previously could not be otherwise demonstrated: the improvement of Robert Hooke's air pump after Guericke's model with which he could undertake his trials. In a detailed chapter Shapin and Schaffer show how the facts won in this experiment could only exist in seventeenth century Europe, where an air pump could be successfully reproduced.

Secondly, a social technique he took from law practice: he used witnesses as a sufficiently trustworthy guarantee of the truth. The witnesses must be reliable and their testimony creditable (Shapin and Schaffer 1985, p. 336).

And thirdly, he used a technique of writing: the description of the experiment had to be presented in writing in such a way that the "modesty" of the experimenter and the witnesses was made clear, so that the results, in that they are independent of the work that *necessarily* had to be carried out, could be seen to be valid and independent of their particular location. Even though the experimenter is the author of the scientific text, and even signs what has been written, s/he must resign from this position. Isabelle Stengers writes:

> What matters is that their collegues are constrained to recognize that they cannot turn the quality of authors into an argument against them, that they cannot localize the flaw that would allow them to affirm that someone who claims to have 'made nature speak' has in fact spoken in its place. This is the very meaning of the event that constitutes the experimental invention: *the invention of the power to confer on things the power of conferring on the experimenter the power to speak in their name.* (Stengers 2000, p. 89)

One could add to this the techniques of self abeyance that were necessary for the participants, the experimenter and the witnesses, despite the somatic presence of their bodies, and with them, their straying passions and deceiving needs, to place themselves on the sidelines within an inner distance.

Boyle, or more exactly, Boyle and his air pump, did not just prove the existence of air pressure with this constellation, but, in this process, they also rearranged the relationship of man to god, to politics and to nature, suffocated birds and stood contemporary ideas of masculinity on their heads—things which are irreducibly bound with one another and which have not only enduringly influenced the relationship of mankind to the world and to itself, but also the conditions of possibility for fundamental changes to these world and self relations.

This will all be discussed later, in Chap. 3. But, above all, Boyle brought the social and the technological spheres closer together than ever before. Understanding Boyle's air pump is also a way of understanding the role of constructivism in the twentieth century. For constructivism—and with it, the renewed support of positivism as well as a fashionable indifference to epistemological questions—can be understood as the result of an effort to understand the construction processes in the laboratory without taking into account the artificiality of the laboratory itself; in

this respect, radical constructivism is also not radical enough (with reference to the theory of *Bildung* see also Sect. 4.4).

If, after the end of the great narratives (Lyotard 1984), one recounts one of the great narratives, such as the invention of experimental science, then it is certainly advisable to point out that Boyle is represented here as the protagonist of a repeatedly well told (hi)story of science and not as a genuine founder of a new epoch.

The story is good not so much because it is factually rich, and perfectly told, but rather because it offers a plausible abstraction from the confused tangle of details which cannot be here presented in their entirety, appropriately reduced to the argument between just two protagonists, namely between Robert Boyle on the one hand, and Thomas Hobbes on the other.[32]

The decisive moments, namely, the recurring renewal of the division [*Teilung*] of the world through the experiment, and the division of a rationality of exploration previously thought to be irreducible, by the invention of the experiment (a division of the "scientific world", or the recognition of this), are preserved in this movement and, simultaneously, are rendered presentable—and this is what is important here.

In recounting Boyle's story I have (preferably, but not exclusively) followed the research put forward in 1985 by Shapin and Schaffer, in *Leviathan and the Air-Pump*, which, in the course of time, has become a classic in its own right,[33] about the epistemological debate regarding the legitimacy of experimental research between Thomas Hobbes and Robert Boyle.

In addition to this, I refer to Shapin's later and more generalised account in *The Scientific Revolution* from 1996—the book about the not-having-occurred of the scientific revolution;—Isabelle Stengers' more politically motivated account, especially in *The Invention of Modern Science* (2000); as well as Latour's essay *We Have Never Been Modern* (1993), influenced by Shapin's and Shaffer's research, while taking into account the objections raised against it, which he addresses above all in *Reassembling the Social* in 2005.

There is certainly no lack of criticism of Shapin's and Schaffer's account of the beginnings of experimental science: they do not fulfil what they programmatically promise (namely, openly addressing the questions posed by themselves about the nature of the experiment):

[32] I consider this strategy to be legitimated by the reasons put forward by Jürgen Osterhammel in his History of the eighteenth Century. He justifies his route that he himself terms experimental, with the end of the great narratives declared by Lyotard, in the following manner: "'Master narratives' are legitimate. Their postmodern critique has not rendered them obsolete, but has rather made them more consciously narratable. One can freely establish such *grand narratives* on different levels." (Osterhammel 2009, p. 19) In this sense, one could begin the history of the forgetting of technology with the arguments with the Sophists or, as has become customary, the story of the experiment with Galileo by C. P. Snow.

[33] It has advanced to being a classic despite certain delays in its reception: it was translated with some delay into French and Spanish, and its reception in German speaking countries first took a detour via research in the social sciences, due to the lack of a German translation, and was brought to a wider audience mainly through cursory remarks by Latour.

> How is an experimental matter of fact actually produced? What are the practical criteria for judging experimental success or failure? How, and to what extent, are experiments actually replicated, and what is it that enables replication to take place? How is the experimental boundary between fact and theory actually managed? Are there crucial experiments and, if so, on what grounds are they accounted crucial? (Shapin and Schaffer 1985, p. 14)

Latour referred to their inconsistent argumentation (1993, p. 25), others have referred to their implicit positivism and the lack of consideration of fundamental rules of history, (for an overview, cf. Zittel 2002), while others point to the incorrect interpretations of their book (such as Bloor 1999 on Latour's interpretation).

And indeed: if this were a historically exhaustive account of the experiment, then one would need not only to consider Boyle and his adversary with reference to the extraordinarily heterogeneous background of the culture of knowledge at that time, one would also have to, above all, take Boyle's predecessors into consideration, together with the involved, and anything but straightforward, history in which the experiment slowly, and with repeated setbacks, established itself as a legitimate form of knowledge accrual.

In such a story, which neither began with Boyle, nor with Galileo, in which Bacon must be taken into consideration just as much as Gilbert, and probably even Parcelus must be accounted for, in which the British Royal Society would appear less as the singular representative instance of Boyle's method, rather than as the fractious club of variously interested noblemen which it obviously was (cf. Purvey and Bowen 1960), Boyle would hardly figure as *the* founder of modern science and Hobbes, his philosophical rival, would by no means well fit the role of the foremost champion against the experimental world that Shapin and Schaffer have made him out to be, especially in later texts which have been based upon this study (as is this one).

In addition to this, the experiment itself would not appear as the singularly invented and, afterward, the constantly maintained, institution that it might appear in the following (hopefully in a sufficiently abstract form).[34] However, the point is not to provide a historically exhaustive account of the experiment. Boyle is a suitable candidate for the story's protagonist mainly for pragmatic reasons: firstly, the story has been repeatedly and successfully narrated with him in the central role; secondly, his experiment had already been well documented by him, and with it, also the associated efforts, including the strategies he followed in order to establish the experiment as a legitimate form of knowledge acquisition; thirdly, Boyle was successful in making his air pump experiments a heuristic model for modern science—they are to be found at the beginning of the famous *Harvard Case Histories in Experimental Science*,[35] and today still belong to the standard repertoire of the propaedeutics of natural science in schools and universities (cf. Dunker and Scheffel 2007).

It is, therefore, less about a historical treatise on the story of the experiment, but much more about obtaining a glance at the reconfiguration associated with the establishment of the experiment as a legitimate form of knowledge acquisition, and

[34] Berg (2008) remarks that this is not so with reference to Lorraine Daston.

[35] This is the essay *Robert Boyle's Experiments in Pneumatics* by James Bryant Conant (1948).

the consequences which we today have to deal with in a very real fashion when we come into contact with technology, technically mediated discoveries and technically conditioned transformations of relations to the world or to the self. In other words, the reconfiguration of the relationship of transcendence and immanence, of man and technology, of time and space and other relationships relevant to the transformation of the role of technology, whereby it enables the understanding of both changes formative of, and drawn from, science, as well as those more universally grasped, fundamental changes in world and self relations and, as a consequence of this, the problems of considering technology in fundamental changes in world and self relations as a whole.

Presenting this protracted reconfiguration, based on the example of an experimental setting, does not mean claiming that everything had been finally decided with Boyle and his air pump (the proof that is was not so has already been provided with more clarity than could be wished for by the Royal Navy and their stance toward lemons).

It also does not mean claiming that Boyle's air pump is the causal reason for all these changes. Most probably, the changes being investigated are those that affect completely heterogeneous areas of knowledge, and the desire to construe causal relations between these—as in all simultaneously occurring phenomenon—would be futile, and which the appearance of the experiment is just a single example of, albeit a decisive one for the overarching question behind this work.

Most probably, the sort of changes being looked at are those which one could relate to the changes which Foucault analysed in "The Order of Things: An Archaeology of the Human Sciences" (deciding upon this is neither the aim, nor within the scope of this work). However, those changes which are better analysed with the help of, in the Foucauldian sense, an archaeological rather than a classical historical method, are most certainly the focus here.

It is for this very reason that the criticism levelled against Shapin and Schaffer by, for example, Zittel (2002), namely, that Boyle has not been understood decisively enough from the perspective of his time, fails to see the essentials. The interesting factor in Shapin's and Schaffer's story is not that Boyle should be understood as a historical player in the context of his time, but rather to understand the radical changes in the time *itself*, using Boyle as an example. And, if I have understood them correctly, that is also their interest; even if they hardly show Boyle's relation to other experimenters, they decisively distance themselves from the casual, matter of fact manner with which the experiment is considered a historical necessity by many writers of scientific history, taking it instead to be a contingent achievement which required a considerable amount of effort.

And Shapin and Schaffer are more historically sensitive than other historians in at least one sense: they do not interpret Hobbes as being exclusively the state theoretician he appears to us to be today, but, rather, they equally consider his scientific writings which, at the time, were thought to be very important, whereas now they hardly register. The reverse is the case with Boyle, where they scrutinize his writings on political philosophy, which drew much attention then, and little now.

However, reading Hobbes as a natural scientist and natural philosopher is less original than one might suppose[36] on first appearances (which quite possibly result from his suggestion to square a circle).[37] He actually eventually disappears in this role from the curriculum of Scottish universities toward the end of the eighteenth century while, in his time, his thoughts on mechanics were compared to those of Descartes and Gassends (Shapin and Schaffer 1985, p. 8).

What in the Royal Navy of the eighteenth century appears from today's perspective to be simply stupid, and what actually proved at the time to be the disastrous case, namely not to take experimentally produced facts into due consideration, is declared by Hobbes in his argument with Boyle to be the only reasonable course of action in the face of, in his eyes, such a methodologically doubtful procedure. He positioned himself unmistakably against the "experimenters":

> Those Fellows of Gresham who are most believed, and are as masters of the rest, dispute with me about physics. They display new machines, to show their vacuum and trifling wonders, in the way that they behave who deal in exotic animals which are not to be seen without payment. All of them are my enemies. (Quoted from Shapin and Schaffer 1985, p. 112)[38]

It was a horror to him that the experiment could at all become a leading method: "If the sciences were said to be experiments of natural things, then the best of all physicists are quacks."[39]

Hobbes was certainly not alone in his opinions. It was much more Boyle who had to fight for the recognition of his experimentally established facts and that the experiment represented a legitimate method. However, "fight" is not really the correct term. The way in which Boyle proceeded could be read as an object lesson in the stratagem, in which a war is won without a struggle. He avoided the struggle by so changing the conditions of the battle, which Hobbes had taken for granted, that Hobbes was left standing alone on the battle field without his troops.

What Hobbes appears to have above all assumed is the certainty that "opinion" and "knowledge" are two entirely separate and incompatible things. This is why, for him, Boyle's efforts to come to a functional equivalent of knowledge through the aggregation of indices (evidence from selected persons, phenomenon, which would otherwise be absolutely unobservable in free nature, created by self-made machines, badly formulated, even contradictory arguments etc.) which, taken alone,

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[36] This concerns, one must qualify, the mainstream. Articles about Hobbes as a natural scientist have been sporadically appearing without any recognizable connection since the thirties in the twentieth century.

[37] Namely in *De Corpore* (Hobbes 2009/1665).

[38] Sir Thomas Gresham was the chairman and namesake of a predecessor society to the Royal Society as well as the founder and benefactor of the college named after him, in which the Royal Society was also founder and, like Boyle, stood for the research on experimenting.

[39] Hobbes quoted from Shapin and Schaffer 1985, p. 128. In the original *Mathenaticae hodiernae* the term was *pharmacopeia* which could quite simply mean chemist. However, Shapin and Schaffer interpret it in the context of the polemic in which it is not about chemists, and more aptly translate the term as *quacks*.

would be insufficient, were tantamount to a corruption of the business of knowledge and truth.

Here, Shapin and Schaffer refer mainly to Ian Hacking's influential research, *The Emergence of Probability* (1975), in which he assumes a clear epistemic break in the middle of the seventeenth century, between the time of the radical distinction between opinion and knowledge, and the emergence and reinforcement of thinking in terms of probability. They consider Boyle to be a decisive agent in this transformation:

> To identify the role of human agency in the making of an item of knowledge is to identify the possibility of it being otherwise. To shift the agency onto natural reality is to stipulate the grounds for universal and irrevocable assent. Robert Boyle sought to secure assent by way of the experimentally generated matter of fact. Facts were certain; other items of knowledge much less so. Boyle was therefore one of the most important actors in the seventeenth century English movement towards a probabilistic and fallibilistic conception of man's natural knowledge. (Shapin and Schaffer 1985, p. 23)

The radicality with which Hacking speaks of a break in history, in the research cited by them, is admittedly later (after the appearance of *Leviathan and the Air-Pump*) clearly revoked in a subsequent debate, and Hacking himself also depicts this break much less radically in 1990 in the book *The Taming of Chance*.[40]

This, however, changes nothing in the fundamental, albeit tentative, rebuttal of a radical distinction between knowledge and opinion, and the increasing acceptance of probability in the discourses of truth. Boyle, on the other hand, distances himself from the very beginning from this distinction, and decisively introduces probability into the very heart of the experimental method and thus also into the discourse of truth. For Boyle, probability plays a role above all in the introduction of witnesses. For him, the act of testifying scientific facts, exactly as in the judicial process, is a business for several:

> For though the testimony of a single witness shall not suffice to prove the accused party guilty of murder; yet the testimony of two witnesses, though but of equal credit… shall ordinarily suffice to prove a man guilty: because it is thought reasonable to suppose, that, though each testimony single but *probable*, yet a concurrence of such probabilities, (which ought in reason to be attributed to the truth of what they jointly tend to prove) may well *amount* to a moral *certainty*, i.e., such a certainty, as may warrant the judge to proceed to the sentence of death against the indicted party. (Boyle quoted from Shapin and Schaffer 1985, p. 56, my italics)

Shapin and Schaffer point to the fact that this arrangement of testimony is less aimed at mutually producing a correct description of nature, thereby making the witnesses co-authors, but rather at securing the legitimacy of the experimenter's actions—as in a judicial process where the witnesses are also not involved in the passing of a sentence:

[40] For an introduction also see Hacking 2001. For a critique of Hacking see Garber and Zabel 1979. An overview of the history of its influence is provided by Daston 2007, and regarding associated literature, Franklin 2001. And for a comparison see Schneider 1988 and Hald 1990.

> The thrust of the legal analogy should not be missed. It was not merely that one was multiplying witnesses […]; it was that *right action* could be taken, and seen to be taken, on the basis of these collective testimonies. The action concerned the voluntary giving of assent to matters of fact. The multiplication of witness was an indication that testimony referred to a true state of affairs in nature. Multiple witnessing as accounted an active licence rather than just a descriptive licence. Did it not force the conclusion that such and such an action was done (a specific trial), and that subsequent action (offering assent) was warranted? (Shapin and Schaffer 1985, p. 57)

And, just as in a judicial process, testimony, no matter how much it refers to technology, and no matter how much the manner of its use demonstrates a technical, cunning character in the sense of a *techné*, cannot be delegated to technology.[41] It can, however, be rendered invisible, and perfected in this invisibility until the point that it corresponds to the exhibition of the truth so that not even the case of a judgement is required.

Daston and Galison show that, with the ensuing rise in the fashionability of the ideal of objectivity in the nineteenth century—a rise which one can understand in terms of a further step in the protracted establishment of the experiment as a legitimate form of discovering knowledge –, the concept of "judgement" lost its meaning as an act of pragmatic reason, and was rejected as the intervention of a subjectivity until it was only a statement that meant what anyway exists. (Daston and Galison 2007, p. 19)

2.5 How to Philosophize with a Pump

Hobbes makes the separation of knowledge and opinion a precondition of his critique when he, for example, takes the necessity of repeating an experiment as evidence of its fundamental fallibility (Shapin and Schaffer 1985, p. 111). Boyle does not now try to prove to Hobbes that something probable can also be true or—as one would probably do on reflex today—attempt to persuade him that knowledge cannot be radically separated from opinion, and that nothing would remain if one insisted upon such a strict understanding of truth.[42] He instead rather creates a setting, with the help of his air pump and his social contacts, so that sufficient creditable men are able to honestly bear witness that the demonstration of that shown has led to such a sufficiently persuasive degree of certainty that they would use the results—regardless of what they might make of them individually—as the basis for further consideration and action.

The fact that an increasing number of witnesses were scientists meant that they themselves made the results the basis for further result oriented actions. From this

[41] Derrida also points this out in a talk with Stiegler (Derrida and Stiegler 2005, p. 94 ff.). His example is the case of Rodney King who obtained fame on the basis of a clear video (white police beat up a black man lying on the ground). The video cannot give testimony—it is the cameraman alone who can testify what he saw (through the camera lens).

[42] Gettier 1963 shows that, for example, the normal definition of knowledge as "justified true belief" is false.

arose the dynamics, which can today, in hindsight, be described as the autonomation of the scientific system by system theoreticians, and enabled their description as an autopoetical scientific system, in which the connectability of insights is advanced to a criterion for truth (cf. Luhmann 1992b).

As such, Boyle did not defeat Hobbes and his philosophical acolytes either by using their means or by using other means. He rather disempowered them, and relegated them to the sidelines of the event where, even today, many still reside, wondering that "philosophising" has been degraded to a synonym for inconsequential reasoning.

If the philosopher was earlier the central figure in the discourse of truth, deciding between truth and simple opinion, now s/he is only responsible for making all those distinctions, which are fully irrelevant for others, between such a knowledge base that it is sufficiently certain enough for every reasonable person to use as basis for their future decisions, and *really* true knowledge (i.e. at present and above all: knowledge based on geometry and logic).

One can thus understand Richard Rorty's demand that philosophers should finally stop engaging in epistemology, so creating more criteria for "real knowledge", and instead edify themselves, i.e. manage to think without resorting to such a fundament, as a late capitulation of philosophy in this debate (cf. Rorty 1979, esp. Chap. 8).

What, in the eyes of Hobbes, makes Boyle a quack, is the fact that he never even attempts to ground his findings on a certain fundament. He does not even once make an attempt at a serious justification: "Thus, in the first of the *New Experiments*, Boyle claimed that his 'business [was] not […] to assign the adequate cause of the spring of the air, but only to manifest, that the air hath a spring, and to relate some of its effects.'" (Shapin and Schaffer 1985, p. 51).

What now makes him a *dangerous* quack is the validity he claims on the basis of these unfounded statements: for it is nothing other than nature itself that he, together with his gentlemanly colleagues, claim to represent—whether or not everyone else considers his results to be absurd, they should accept them and keep silent: a vacuum, that is, *nothing* conducts light. Period. Without explicitly mentioning Hobbes at this point, Rorty strikes at Hobbes's *natural* philosophical fears with a well known turn of phrase taken from Hobbes's *political* philosophy: "To suggest that there is no such common ground seems to endanger rationality. To question the need for commensuration seems the first step toward a return to a war of all against all." (Rorty 1979, p. 317).

Indeed, Hobbes's natural philosophical doubts are obviously motivated by the same experiences as his political philosophy: the horror of the 30 year war, in which war fed war, and the English civil war in which the life of a person was nothing more than "solitary, poor, nasty, brutish, and short" (Hobbes 1909, p. 99; see also Latour 1993, p. 18 ff.). [43]

Rorty's extensive efforts to prove that there can be no common foundation for all knowledge, that knowledge cannot be derived from a certain ground, appear almost

[43] In this respect Hobbes's political philosophy holds a certain irony, the Leviathan itself being built according to the image of a machine (cf. Callon and Latour 1981).

clumsy in comparison to Boyle's tactics. Rorty takes on the epistemologists in their own field and attempts to prove that there can be no common foundation using philosophical means. Boyle, however, establishes facts with the help of his air pump which simply allow the efforts of the "epistemologist" Hobbes to run out of air.

The further that the experimental method is established, and facts created which become the basis of the actions, decisions and thoughts of an increasing number of people, until we today are unable to take a single step, make a single grasp, without thereby equally confirming the legitimacy of the experimental method, and our fundamental trust in it, the less imposing an instance appears which belatedly confers, or refuses to confer, the philosophical stamp of approval.

In the face of this, the attempt to counteract one's own insignificance by declaring, without hesitation, to be responsible for all that experimental science has not yet declared to be its own object of knowledge, and then, as a result, to attempt to defend oneself in a prolonged retreat, looks all the more desperate. Stengers sees the critical breakthrough in this publicly enacted dispute over the recognition of experimentally produced facts decided with Galileo:

> When Galileo wrote that one man will win against a thousand rhetoricians, whatever their gift for persuasion or the authority of their references, if this one man has the facts on his side, we usually recognize it as some kind of positivist statement. And indeed Galileo was in the process of building the first public representation of experimental science, producing a state of affairs where experimental facts claim the power to silence both philosophers and theologians. (Stengers 2005, p. 156)

Stengers also adds that Galileo also did not achieve this alone, but rather could have done so only with the aid of just that recognition producing technical-experimental arrangement, which means that he can be considered to be the creator of the experimental just as little as could Boyle: "But we should not forget that the Galileo who was writing was himself the product of the first experimental achievement, the first experimental knot." (Ibid.).

In how far Galileo was first setting about "building the first public representation of experimental science" without simply being able to fall back upon just that, can be exemplarily seen in the difficulties he had convincing contemporaries of the existence of Jupiter's moons. These contemporaries were not sufficiently familiar with the technology being used to be able to forget that the technology was being used. They peered into Galileo's telescope and shrugged their shoulders. One wrote: [Galileo] "has achieved nothing, for more than twenty learned men were present; yet nobody has seen the new [moons] distinctly. […] Only some with sharp vision were convinced to some extent." (Quoted from Shapin 1996, p. 73).

And even those who believed they could make something out with their sharp eyes could not be absolutely believed, after all, the senses, according to the views of many theologians in Galileo's time had generally become too vague after the fall that they could reliably bear witness to something (ibid.).

This was not simply short-sightedness, and also not simply an absence of skill in distinguishing errors which might be produced by the telescope from the real images it displayed. Rather, because there was no possibility for comparing the technically produced image in the telescope with a non-technical image outside of

the telescope—after all, one could not simply get closer to Jupiter to see the moons with one's own eyes—the only way leading to a true view of Jupiter's moons (or would someone claim they did not exist?) was via the acceptance of the telescope as a technology the artificiality of which could be forgotten. It had not yet completely become an "intermediary" (see Sect. 3.16).

Since the technical side of the telescope could be forgotten (and only "analytically" again added), it has considerably extended the world's undisclosed area, which is then open to further exploration. However, because Galileo did not have the social arrangements provided by Boyle's laboratory at his disposal, it was insufficient to simply allow a number of selected gentlemen to use the telescope, even if those gentlemen may have had access to a much larger repertoire of technology the artificiality of which had already been forgotten.

In order to establish it as a generally reliable means he would have had to persuade citizens who were not considered by a scientific community to be competent and trustworthy, but rather by the people themselves. This was a task immeasurably more difficult than persuading a few prepared and likeminded colleagues about an innovation, there also being among them incorrigible sceptics such as Cesare Cremonini, the professor of natural philosophy from Padua about whom—and there is little better indication—we today laugh.

This professor from Padua did not even want to look through the telescope in order, as we say today, to prove with his own eyes the existence of the moon, but would rather hold dear the ancient scripts.[44] He is one of the favourite figures in the heroic historiography of science, in which Galileo's contemporaries find it so difficult to accept his openly demonstrated truths because their view is so marred by prejudice and religious dogma (cf. Lange 1974/1866, p. 461 ff.).

However, it is the telescope which, in its opacity, has not yet become a pure medium (cf. Sect. 3.4) and has unmetaphorically marred the view. In truth, Galileo's telescope was indeed defective, and produced many errors. Why should looking into such a tube convince one of the existence of Jupiter's moons? How should one know that the telescope proves anything—and doesn't just show something? Not at all, Feyerabend concludes (1975, p. 104 ff.), Galileo simply believed in the telescope,[45] he had no theoretical reasons, not to mention proof, to show.

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[44] The idea that the ancient texts are near to the truth is one which was widely spread in Galileo's time. It emanated from the idea of a gradual corruption of knowledge in the course of history, an idea Galileo was also not free of: "Galileo maintained that Salomon and Moses 'knew the constitution of the universe perfectly', and later Boyle and Newton reckoned that there might be a chain of specially endowed individuals through whom the pure and powerful ancient wisdom had been handed down intact, both intimating that they themselves might be present-day members of this lineage." (Shapin 1996, p. 74). Undoubtedly, the present is also not free of such an idea of corruption, especially in the humanities in which there are still regularly disputes enacted as to who prefers to follow the origin of a thought back to an even older author.

[45] Galileo himself writes: "About ten months ago a report reached my ears that a Dutchman had constructed a telescope, by the aid of which visible objects, although at a great distance from the eye of the observer, were seen distinctly as if near; and some proofs of its most wonderful performances were reported, which some gave credence to, but others contradicted." (Galileo 2004/1610, p. 6).

Thus, it was both his and science's good fortune that he was not involved in the theoretical debate about the reliability of this technology (cf. also Heidelberger 1981, p. 130 ff.), but rather simply applied it. As long as the telescope was not yet so engineered that it could be forgotten as a neutral medium it was a thorn in the side of the philosophers who, like Hobbes, saw themselves obliged to keep to the pure truth, unpolluted by technology.

If only it could at least be seen as a product of science! But this was not so. Descartes complained of this in 1637 when he wrote that the telescope was not invented systematically by the sciences, but rather simply "through experience and lucky circumstance" in practice.[46]

Then, in 1611, Galileo had an idea: he invited Rome's philosophers to stand on a hill, and to look together with them through the telescope through the window of a nobleman, and to decipher the names written on the walls of his gallery. Then that which was seen could be easily proved by visiting the site, whereby the function of the telescope would be proved. A brilliant idea. And the audience? They reacted once more with shrugs of their collective shoulders: "Many of these witnesses allowed that though the telescope worked 'wonderfully' for terrestrial vision, it failed or 'deceived' in the celestial realm." (Shapin 1996, p. 73).

Every breath today proves the existence of air pressure, and every gaze aimed through a telescope can prove the existence of Jupiter's moons; it would thus be incorrectly understood if one said that the sole point of an experiment is to let something come to light. It must be witnessed. And what the witnesses witness as being something, and not something else, does not simply depend upon whether they are open minded or, like the professor from Padua, don't want to look at all, but also depends upon the respectively prevailing world view and the expectations associated with it, an *observation trained in dealing with the respective technology* (and not just the observation).

Daston and Galison have shown, among others, by means of the training function of atlases and botanical preparations, how specifically observation is adapted to a certain community and a certain apparatus, and how expansively it must be trained in the ever ongoing specialisation of the sciences (Daston and Galison 2007) in order that one is in a position to be able to differentiate the typical from the atypical, and the true from the false.

It would be a momentous miscalculation to believe that these public debates between the advocates and the opponents of the experiment, with Boyle and Hobbes as their most prominent representatives, would be a dispute which was carried out and decided upon paper and in speech alone. If one believes this then one would, on the level of reflection, keep technology out of the debate in the same way that Hobbes all the while attempted to—even if one presents Boyle as the winner of this dispute.

For Hobbes, it went without saying that the air pump could not philosophise, not even in natural philosophy, and it was also otherwise unsuitable to bring closer any

[46] In the original: "[…] à la honte de nos sciences, cette invention, si utile et si admirable, n'a premièrement été trouvée que par l' expérience et la fortune" (Descartes 1953/1638, p. 180).

kind of truth about nature. Boyle, on the other hand, succeeded in bringing the air pump not only to create facts about nature, but also, over and above this, to decide upon the legitimacy of the experiment in the ongoing dispute in natural philosophy.

So, while Hobbes believed he was engaged in a debate with Boyle, about whether one could gain knowledge about nature using technology—a debate which, according to Hobbes, must be resolved *before* its use—Boyle had mobilised the air pump not only in winning knowledge about nature, but also, beyond this, in deciding the philosophical debate with Hobbes to the advantage of Boyle, the air pump and air pressure.

The arrangement of air pump, witnesses and documentation had exactly the aim of creating facts and thereby bring all doubters into the position of having to oppose the testified facts. Boyle did not make the neutral suggestion to vote on whether one could experience something about the elasticity of air with the help of his apparatus, so that it could then be discussed. He rather construed, with the aid of the social, mechanical and textual technologies, the arrangement of the experimental demonstration to address precisely those circumstances of doubt, not with a will to discuss, but rather with the will to decide the debate in favour of himself, by degrading the discussion to a sideshow.

Hobbes did not see that the discourse of truth was itself dragged into this conglomerate of technologies. And not by just suddenly assigning voice in the discourse of truth to a technical device such as a vacuum pump, but rather that the whole discourse of truth has itself been altered to such an extent, by the sly transformation of a technologically savvy hero,[47] who avoids the direct confrontation with the 'truly' superior opponent, that the technician is able to influence it.

2.6 The Techné of the Technology of the Experiment

> Machines take me by surprise
> with great frequency"
>
> —Alan M. Turing 1950

One finds this character in the stratagems of many classical authors.[48] The ruse is obviously not only, or not without reason, etymologically bound to technology.[49] The cunning [or tricky] character of *techné* does not also simply mean the superiority of the intellect as opposed to physical strength, as one normally assumes, and

[47] Who, however, from the classical perspective, appears as an anti-hero, or, as one could say with Neiman (2008, p. 289 ff.), marks the transition to post-heroism.

[48] Thus in Sun Bin's *The Art of Warfare* in Chap. 8: *Terrain as Treasure* where he writes about the advantage in being able to determine the terrain (2003). Or Sun Tsu's famous dictum about the peak of warfare: "and those who understand the art of war defeat the enemy without battle" (2005). Cf. also Jullien 2004.

[49] See also the footnotes at the end of Sect. 1.

whereby the ruse can be understood as a means of the intellect, for example, by Johannes Bilstein (2001, p. 280).

Rather, it must actually be understood as a characteristic of technology itself: for, if Boyle had simply, with his intellect, outplayed an intellectually inferior Hobbes, then this would hardly be a particularly convincing way of telling this story.[50]

Thus Boyle, with his sly plans, is similar to many technologically savvy heroes in history: he defeats an apparently superior opponent in a manner that his opponent had not at all foreseen, with the difference, however, that he did not, as did Hephaestus, have to do with a hugely powerful, but somewhat stupid opponent such as Ares, a "wooden head, a hitman" (Köhlmeier), or like Zeus dealing with a titan such as Chronos, or Odysseus with a naive creature such as the Cyclops. Rather, he has to do with an intellectual Oxford scholar, who was already considered to be a prodigy at the age of four.

The entire history of scientific theory, in which the experiment and the technology involved therein, is always relegated behind theory and claimed to be simply an instrument in the hands of the theoretician ("Thus it is he [the theoretician] who shows the experimenter the way. But even the experimenter is not in the main engaged in making exact observations; his work, too, is largely of a theoretical kind. Theory dominates the experimental work from its initial planning up to the finishing touches in the laboratory." Popper 1972, p. 107), can be read as an imaginary re-appropriation of the power over truth by intellectuals, or at least the intellect, long after they had to share it with the technicians.

Hobbes, always the philosopher, sees all the problems in the fractious debate about the vacuum based on imprecise language, in conceptual incoherence. For him, it is:

> [an] *absurd* metaphysical language as a principal source of these difficulties in natural philosophy. He pointed out the dangerous consequences of incoherent speech about empty space, and analyzed the linguistic differences between rival natural philosophical schemes developed in the 1640s, notably of Descartes. (Shapin and Schaffer 1984, p. 84, emphasis from the original)

And if one looks at the conceptual incoherence pervading Boyle's writings, then one can indeed side with Hobbes and his heirs and even today wonder that something useful arose from this work (and this wonderment, this just as unavoidable as condescending amusement about Boyle's clumsy use of language is as revealing as the laughter about that professor from Padua or at the ignorance of the Royal Navy). Shapin and Schaffer enumerate a number of these inconsistencies with reference to that which Boyle *somehow* summarises under the "pressure of the air":

> He referred to the 'pressing or sustaining force of the air', or to the 'sustaining power of the air'. In *New Experiments* he discussed the apparent heaviness of the cover of the receiver when evacuated, using the terms 'spring of the external air', 'force of the internal expanded air and that of the atmosphere', and 'pressure' interchangeably. In early experi-

[50] To what extent the trick in technology is more than just a property which can be attributed to it or not, has already been outlined in the previous chapter in the relationship of a problem to the technical solution associated with it.

> ments in the text the term 'protrusion' is used alongside that of 'pressure'. These usages were no more consistent in subsequent essays on pneumatics and the air-pump trials. In the *Continuation of New Experiments* of 1669 and in later texts written against Hobbes, 'pressure' referred to both weight and spring. And in the central void-in-the-void experiment 17 of *New Experiments*[51] Boyle reported that the insertion of the Torricellian apparatus in the sealed receiver did not produce a fall in the height of the mercury in the barometer. He attributed this to the 'spring' of the air inside the still-unevacuated receiver, which was not affected by its removal from the 'weight' of the atmosphere. Thus trials that computed the relation between the air's pressure and its 'density'. 'Pressure' thus embraced spring and weight. (Shapin and Schaffer 1985, p. 53)

Even today one finds attempts undertaken by Hobbes's heirs to free themselves from the impurities of the truth brought about by technology's tricks through reflections on language, only to find that these impurities, like the hedgehog in the fable, were always already there—no matter in which direction the Hobbesian hare runs.

Just as the Boyleian air pump experiment sets a truth corrupted by probability and technical construction in place of true knowledge, so inevitable is the joining of the supplement of writing to speech—and that is Derrida's subject—and in such a manner that one must always represent it as always already supplemented; a speech the truth of which Hobbes sets all his hopes on. And how does Derrida express that which joins speech as writing? "It is the addition of a technique, a sort of artificial and artful ruse to make speech present when it is actually absent" (Derrida 1997/1967, p. 144).

Bernard Stiegler is currently writing a four volume study in which he attempts to prove that, in this sense, technology always shared a part in the truth, and the history of philosophy can also be read as the history of the repression of the "question of technology", as a history of the separation from that which in Homer was still appreciated as cunning: "At the beginning of its history, philosophy separates *tekhnē from epistēmē,* a distinction that had not yet been made in Homeric times." (Stiegler 1998, p. 1) Stiegler meets technology while unearthing the conditions of possibility of experience, the problem of memory as well as recollection as a possibility of knowledge, and relates technology to Derrida's concept of writing. He writes elsewhere reflecting on the genesis of his question:

> I later understood that technology is central to the question of memory. In other words, I do not consider myself to be a 'technology philosopher', but rather a philosopher who, together with others, attempts to show that the philosophical question as such is nothing other than the persistence of a condition, which I term the techno-logical condition, which it *is through* and *through* and that *since the origins* of philosophy. From the beginning onward the simultaneously technical and logical condition is already registered in this texture that language and tools together make up and allows human beings their *exteriorisation*. (2009a, p. 27)

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[51] The "Vacuum in a vacuum experiment" can be traced back to the attempts of Evangelista Torricelli to place a mercury filled tube with its opening facing downwards over another mercury filled container—so that a visible vacuum formed above. The experiment became known in 1647 in Blaire Pascal's version of it, under the French name *vide dans le vide*. Here Pascal placed a barometer within another barometer via which he could alter the air pressure in the innerer barometer and so demonstrate that the height of the mercury meniscus was dependent upon just that air pressure. Cf. Genz 1994, p. 18 ff.

Thus, this problem did not first appear with the modern sciences. However, it has grown into a problem difficult to ignore in the course of its differentiation and increasing significance, mediated by the spreading of all things technical:

> If the relationship of philosophers to technology presents itself as an essential, originary and permanent *conflict*—and so it is since Plato—the situation has been complicated since the 19th century. While technology has neared science via industry (it is the rise of technology in its own right), the world of the 'intellectuals', as it comes to be known, is cut off from the technical which has now become technology in the same breath as it has been from science, from the economy and finally also from political economy. (Ibid., p. 28)

In other words: if technology continues to be dealt with as just one subject among others, as if it were an object outside of philosophy and *Bildung*, instead of accepting it as a challenge to thought, then the space from which it is dealt with will remain the sidelines of a game played out by others.

The main focus of Shapin and Schaffer lies in the manner Boyle manages to convince his opponents and the public of the reliability of his experiments. The controversy between Hobbes and Boyle is thus an argument about the legitimacy of experimentally won *results*. Not much is thereby said about the experimental *process* and the process of knowledge acquisition, and it is also insufficiently clear as to whether it is *techné* itself which participates in the process of knowledge acquisition.

It will come to be seen that even Boyle, in his delimitation to Hobbes, and in his thought of the experiment, still remains within pre-experimental thought. A way of thinking which should be designated an explorative thought system in order for it to fulfil the various different requirements assigned to it.

However, only when the reflection of the experiment itself takes place at the level of the experimental can the experiment be adequately thought; we are here concerned with the acquisition of knowledge. The acquisition of knowledge is nothing other than the knowledgeable disclosure of a shared world, and is thereby itself won either explorationally or experimentally.

2.7 The Experiment in a Divided World

It has become the norm to make the fundamental interminableness of knowledge the starting point of any reflection about science.[52] Knowledge is fundamentally interminable insofar as it is impossible to transform all non-knowledge into knowl-

[52] At this point a conceptual clarification is appropriate: knowledge and non-knowledge present here a specific form of disclosedness or undisclosedness. Realisation should be thereby designated as taking place at that point where non-knowledge is transformed into knowledge and knowledge into non-knowledge. The knowledgeable disclosure of the world thereby represents only one possible form of world disclosure among others. One can know much about the countryside but this does not mean one has disclosed the countryside itself, one has merely disclosed knowledge about this countryside. As long as it has not, for example, been disclosed as to the possible modalities of transport then one cannot move around within it. The fundamental distinction between disclosed

edge because knowledge itself produces non-knowledge and it is never certain that this knowledge can be protected from its own revision.[53]

The idea that behind all newly won knowledge new non-knowledge will be recognisable, and so the interminableness of knowledge acquisition is itself renewed, is expressed in the different variations of the metaphor of the inevitable and infinite deferring horizon.[54]

This insight, expressed in this form, will then be brought to bear against e.g. a teleological idea of science which amounts to a world understood in its totality or, more generally, against the idea of scientific "progress".[55]

As with most ideas that one sees posited with a rigid, knee jerk reaction against a positivism quite obviously still not dead enough, this idea also generalises the realisation, which hardly causes a stir, in such a way that it loses almost all analytical leverage and so leaves hardly any room for reflection upon the relation between knowledge and non-knowledge.

However, reflection about processes of knowledge acquisition begins firstly there where, in the insight into the fundamental interminableness of knowledge, one puts to one side the understanding that the fundamental interminableness of knowledge does not itself represent the starting point for knowledge acquisition *processes* (not even for those that refer to knowledge acquisition processes). Secondly, it does not deliver any indication of strategies or process structures in knowledge acquisition and, thirdly, that the transformation of knowledge into non-knowledge (and vice versa) means work.[56]

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and undisclosed is intentionally set here as deep as is possible. The advantage of speaking of the work of distinguishing between disclosed and undisclosed and not about the work done on the distinguishing between knowledge and non-knowledge consists in, among other things, that the interconnectedness of the different forms of world disclosure in knowledge acquisition processes can be taken into consideration. If, in this section, the talk is of a knowledgeable disclosure then this is out of respect for the tradition and because the focus is on the sciences, which carry this focus upon knowledge within their name [Wissenschaften in German—trans.]. However, whenever it is possible in the following, the more general work on distinguishing between the disclosed and the undisclosed should be spoken of, and of cognition only then when reference (whether in terms of continuity or breach) to the tradition is to be made clear; in these cases exchanging terms runs the danger of obscuring such reference.

[53] For an overview cf.: Gamm 1994, pp. 100–211.

[54] The same applies to the development of technology, albeit in science's shadow. In a surprisingly explicit section considering technology Husserl writes: "But technology progresses along with mankind, and so does the interest in what is technically more refined; and the ideal of prefection is pushed further and further. Hence we always have an open horizon of conceivable improvement to be further pursued." (Husserl 1970/1936, p. 25).

[55] Cf. Salvadori 2008 on the uncertain future of the idea of progress.

[56] This is not valid for the "cognition" of knowledge from non-knowledge: the promise of pinning to one's jacket the medal of insight into the interminableness of knowledge without working for it is also nothing new. Montaigne says: "When Socrates was informed that the God of wisdom had attributed to him the title of a sage, he was astonished at it, and carefully examining himself, could not find any foundation for this divine sentence. He knew others as just, temperate, valiant, and learned as himself, and some that were more eloquent, more graceful, and more useful to their countrymen than he was. At last he concludes that he was distinguished from others, and

Thus the success of the modern sciences is not based upon their dealings with non-knowledge, but rather on the ability to render acquired knowledge available as *known knowledge* in, and together with,[57] the different forms of disclosure (e.g. data, texts, technology or routines) to other scientific works, including those which are working on the revision of existing knowledge.

This is also valid for processes of *Bildung*, which are naturally not exhausted by looking once to see that knowledge is not conclusive and that all knowledge is fundamentally subject to revision, but are rather, exactly like the sciences, dependent upon knowledge, upon that *known knowledge* which can be referred to, in, and together with, the various forms of disclosure.

Since it is knowledge that is being dealt with (and not fantasy or mere assertions, although this can always turn out to be the case), it is always knowledge of the world that is being dealt with.[58] The amount of knowledge that science can make available in this manner is considerable, and because it is considerable, it has epistemological consequences which are to be made clear in the following.

They create the knowledgeably (in the following more precisely: scientifically knowledgeable) disclosed field of the world, i.e. that part of the world which can be taken for granted by all further research as being *disclosed*. Scientific work therefore travels along the boundary between the disclosed and undisclosed part of the world.

Although these considerations are based upon the conviction that the work of science can be best described as a movement of world disclosure, i.e. as the work of distinguishing between the disclosed and the undisclosed, instead of as a distinction between true and false as, for example, Luhmann suggests,[59] this choice is more simply, namely pragmatically, justified in the following:

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pronounced to be a wise man, only because he did not think himself so; and that his god considered the opinion of klowledge and wisdom, as a stupidity in man; that his best doctrine was the doctrine of ignorance, and simplicity his best wisdom" (Montaigne 1811, p. 129). And this is not only a specifically European insight. In Lun Yü is stated how Confucius turns to his student with the words: "Yu, shall I teach thee what is wisdom? To know what we know, and know what we do not know, is wisdom." (Chap. 2, verse 17. In: Lyall 1909).

[57] The phrase "in and together with" is meant to indicate the analytically incompletely reconstructable transformation processes which are subjected to knowledge and other forms of disclosure. It would be naive to believe that everything that is used and mobilised in science was at sometime already completely understood: ignorance is something other than applicability. Nevertheless, one would not have been able to develop the technologies that have been developed if so much knowledge had not been available. In other words, and only referring to the relationship between technology and knowledge: neither is the history of technology derivable from the history of science, nor is the history of science derivable from the history of technology. Understanding what came from where is the work of the history of science and of technology and this work is not to be analytically cashed in with the turn of a card.

[58] Whereby, of course, science is as well, with its partly esoteric conceptions, itself a part of the world. For the concept of the world see Sect. 2.8.

[59] It may become clear toward the end that this has to do with (with reference to this aspect) the all too great proximity of Luhmann to Popper. If one, however, turns from the distinction true/false to that of disclosed/undisclosed, then the concept of the world is also up for grabs and with it

The interest in the work of science is here justified due to the theoretically and empirically convenient access to the most primordial moments of world disclosure. However, that these are shared with *Bildung* in its individually applied form is empirically difficult to grasp. Thus, it will be simultaneously attempted here to rehabilitate the moment of world disclosure for the theory of *Bildung*, a moment which still played a central role in Humboldt, but, in recent summaries of a transformative concept of *Bildung*, has run the threat of being lost from sight.

Humboldt speaks of *Bildung* as world disclosure insofar as it, as he says in a classical formulation, is concerned with "embracing as much world as it is possible to grasp, and so closely that only he [man] can bind himself to it" with the aim of "relating our ego to the world in the most general, exciting and freest interaction" (Humboldt 1969, p. 235). Therefore, the relation between knowledge acquisition processes in science and the processes of *Bildung* exists here in that both are concerned with processes of world disclosure, or, in the case of their knowledgeable disclosure, with knowledge acquisition processes.

As such, only such processes in science that do the work of distinguishing between the disclosed and undisclosed are being dealt with here. Everything else which still might come under the rubric of science is not dealt with. Such scientific processes of world disclosure are opposed to individual processes of world disclosure, which will also here be primarily considered under the aspect of the knowledgeable disclosure of world. Thus it is those processes of *Bildung* that can simultaneously be considered to be knowledge acquisition processes which are being dealt with here.

Doubtless, there are other forms of individual world disclosure: one opens oneself up by practicing gestures of politeness (and not by knowing about them) to parts of the world which would otherwise remain closed to one (which, of course, knowledge acquisition processes can also bring about). Further examples would be physical training or the accumulation of capital, which can disclose parts of the world that would otherwise remain undisclosed—and these cannot be replaced by knowledge about the significance of capital or knowledge about the significance of physical training.[60]

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the concept of meaning in system theory (cf. Sect. 2.9), whereby the theoretical consequences for system theory would be incalculable.

[60] Making this possible is the function of self help books: they allow the reader to disclose regions of the world which would be otherwise closed via knowledge forming explanations, admittedly only imaginarily (you can already feel rich without actually having acquired money, or you can feel fit without actually having to carry out one's training plan), but with a significant distinction to the open fiction of a novel. Ever since Napolean Hill's (1938) clever move of delivering the reader the legitimacy of imagination by *subordinating* reality to the imagination and bringing it into a conditioning relationship (one must envisage what one wants in order to make it come real), self help books no longer had to orientate themselves along reality's borders but rather toward those of the power of the imagination—borders which allow themselves to be stretched in a similar fashion to the novel.

2.8 The Paradox of the World

> Definition: Distinction is perfect continence
>
> —George Spencer-Brown 1969, p. 1

That which counts as disclosed is all that which—in whatever form: as fact, tool, machine, among others—is knowingly taken to be assumed, or can be mobilised as such, for further work undertaken on the distinction between the disclosed and undisclosed. Conversely, that which counts as undisclosed is all that which was not knowingly assumed, and could not be mobilised as such.

Epistemology had let itself become fascinated with the fact that no knowledge can ever be considered to be complete, so that therefore nothing exists which cannot be subjected to a further revision. The practical meaning of that which must be dealt with as completed has become forgotten beneath the fascination with interminableness.

One can easily recognise this practical meaning if one visualises the amount of knowledge that must be *simultaneously presumed and forgotten* as known knowledge in order to realise something new. If one were to attempt in a laboratory—even if it were as simply constructed as possible—to collect all the knowledge that must be presumed as known knowledge, in order just to prepare a single experiment, and attempt to reflect upon each respective interminableness, instead of simply presuming it to be complete, and therefore known knowledge, one would become enmeshed[61] in an irretrievable complexity of physics, chemistry, electronics etc. just by turning on the light.

Making the fundamental interminableness of knowledge the starting point of the reflections *about* science can therefore mean nothing other than directing one's observation exclusively on the side of this interminableness, so forgetting all that which the starting point for reflection *within* science actually is: all that knowledge that, in its disclosedness, must *practically* be presumed to be complete. However, if one wishes to understand the processes of knowledge acquisition in science then this alone means that the knowledge of non-knowledge is surely a bad starting point.

This is not only valid for the natural sciences and their suitability due to their visible genesis and the especially well illustrated processes of knowledge acquisition present in the comprehensive manner of their documentation, but rather for every form of world disclosure in general, and thus also for the processes of *Bildung*.[62]

Even if the fundamental interminableness of knowledge presents a bad starting point, it is, however, not wrong; neither can something be proved to be completed,

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[61] Compare the documentation of the surprising boundaries of complexity against which the artist Thomas Thwaites struck in the attempt to construct a toaster without any presuppositions: http://www.thetoasterproject.org.

[62] In fact, this concerns knowledge acquisition processes, not the economy of science or its code, which excludes those cognition free processes in which the well known is simply brought out in the scientifically acceptable (in the sense of being quotable) scientific journal. Despite the lack of empirical evidence it is probably not wrong if one assumes that so a large part of the scientific enterprise remains here unconsidered.

i.e. fully disclosed, so as to be permanently protected from revision, nor is the world disclosed as a totality, which is already impossible because it is divided [*geteilt*] (see Sect. 2.10).

But insofar as science can, where it is unable to utilise scientific knowledge, utilise non-scientific knowledge (and must constantly do so), the world in which science works is also not undisclosed and virginal.[63] "The idea that we start from scratch when creating and increasing our possessions", writes Bachelard, "could only arise in cultural systems based on simple juxtaposition, where something that is known is immediately something that enriches" (2002, p. 24), and adds: "Yet when our soul confronts all the mystery of reality, it cannot make itself ingenuous just by decree. It is impossible then to erase every single trace of our ordinary, everyday knowledge once and for all […] Even when it first approaches scientific knowledge, the mind is never young." (Ibid., p. 24 f.)

Thus the world is as well not undisclosed. On the contrary: if one distinguishes non-knowledge that one knows, from the non-knowledge that one does not know, then the non-knowledge that one knows is itself still knowledge,[64] and the non-knowledge that one does not know is not from this world, insofar as it cannot, in this world, be immanently distinguished from knowledge (cf. Sect. 2.9).

Insofar as "world" is the comprehensive concept for everything that is sensually accessible,[65] and *simultaneously* the object of the efforts of knowledge acquisition, it must take on a doubled, paradoxical form:[66] the world is the totality of distinctions made in the world between the disclosed and the undisclosed, motivated by its disclosure.[67] However, thereby the distinction between the disclosed and the undisclosed is itself already a paradox: then everything that is sensually accessible is also disclosed and whether it is only in the form of knowledge about its undisclosedness (the world as a totality of distinctions is thus completely disclosed).

At the same time, there is nothing that could not reveal itself in the future to be, in hindsight, undisclosed, and so, in the present, be valid as finally disclosed: one had just seen the phlogiston escape from the candle and, in the next moment, it has never existed, and it is also evident that the oxidation process was not even known

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[63] To contextualise the explorative strategies of seeing and describing (cf. Sect. 3.5 and further Sect. 4.6) with the image of virginity cf. Haraway 1988 and Haraway 1997a, pp. 173–212.

[64] Cf. Wimmer 1996b.

[65] "Put very formally, sense can be characterised through the exclusion of one thing: that something can be excluded." (Luhmann 2002b, p. 18).

[66] The concept of the world always presents a simple paradox—as a totality of the distinctions between transcendence and immanence in the immanent (cf. Fuchs 2004, p. 13; 2000, p. 40). In Luhmann's understanding the "world" is uninteresting in that one cannot meaningfully delimit it against something other. Here, the world is seen as being especially interesting in that it is both taken to be object as well as condition of the processes of world disclosure, whereby the thought of the processes of world disclosure also exceed certain representational remains of system theory (cf. Friedrichs 2008, p. 197 ff.).

[67] Making a distinction is necessarily accompanied by a motive: "There can be no distinction without motive and there can be no motive unless contents are seen to differ in value." (Spencer-Brown 1969, p. 1).

in the form of non-knowledge. The oxidation process was, before its discovery by Lavoisier, actually not sensibly accessible (i.e. not even in the form of nonsense)—we have this principle to thank for the insight that the world "as such" is not accessible (the world as a totality of distinctions is thus completely undisclosed).

The world is thus simultaneously both: disclosed and undisclosed. And all problems result from the fact that one can only make the distinction between the disclosed and undisclosed in just precisely this world. And this world is a divided [*geteilt*] one (for the consequences for the concepts of the world and of sense also see Sect. 2.9)—one had, to stay with the example, always already shared [*teilte*] it with oxygen and not in the manner of coexistence [*Nebeneinander*] but rather in the manner of cooperation [*Miteinander*].

If one understood the world only as a simple paradox, i.e. as the totality of the distinctions between (wholly) disclosed and (wholly) undisclosed, one would still be forced to transgress the distinction between immanence and transcendence—namely, as if one could make a statement about the world, no matter how abstract it might be, from the vantage point of a space beyond the world; but it has always been the case that when one wished to give this space an address it has always belonged to God.

If one wishes to avoid transcendentalism, which would be bound up with a founding definition of the distinction (or with a transcendental construction aid, such as Husserl's life-world), and one puts the question of disclosedness and undisclosedness (i.e. the question as to how the world is disclosed*)* in an *immanent* fashion, as it is also put for science (and the individual in his/her efforts at *Bildung*), and thus also does so for science, which is dedicated to the disclosure of such forms of disclosedness (and the individual, who works at gaining insight into the processes of *Bildung*), then there remains—I repeat myself—no other choice than firstly, to simultaneously acknowledge both (the world is always completely disclosed and the world is always completely undisclosable), secondly, to acknowledge that the analytical statement that the world can fundamentally never be completely disclosed is still not a statement about the constantly historically shifting distinction between disclosed and undisclosed and thirdly, to acknowledge—but this is already almost banal—that every reference to the world occurs within the world.[68]

To simultaneously think one and the same simultaneously and asynchronously[69] (in other words, "the world is principally undisclosable" simultaneously with "in principle, the world is disclosed" and "tomorrow the world will look totally different", which is to say: that which today counted as being disclosed can already tomorrow count as something undisclosed, or, vice versa, that which today counts as undisclosed can tomorrow already count as being disclosed), is classically illogical

[68] Here, choosing the distinction between disclosed and undisclosed has yet another strategic advantage: some (not all) knowledge acquisition processes in science can also be described as the cognitive processes of individual scientists, which would then fully coincide with the processes of *Bildung*. Replacing the distinction disclosed/undisclosed with the distinction known/unknown or recognised/unrecognised has proved itself to be of as much worth as that of truth/untruth, seen by Luhmann as a code of science.

[69] Cf. Luhmann 1992b, p. 81.

and presses to be semantically resolved (for example, by pointing out that "principally" has an utterly different meaning to "in principle"). However, both are very much intended: the world (as shared [*geteilt*]) is, in the strongest sense of the word, neither disclosed nor undisclosed, but rather both disclosed (we cannot draw the boundaries of the world from somewhere beyond the boundaries of our world), as well as undisclosed (it is worth doing science, it is worth educating oneself; there is nothing that is not potentially subject to revision).

If one is trapped in classical logic in this way, then one must change to a non-classical one. The logic chosen here, and with which one will be placed in the position of being able to simultaneously think disclosedness and undisclosedness simultaneously and asynchronously is Spencer-Brown's calculus of indications.[70] However, to be precise, Spencer-Brown's claim does not consist in offering an alternative to classical logic, but rather offers a mathematical calculus with the help of which logic (and Boolean algebra) itself becomes discernible as derived from this.

The calculus of indications is therefore described as protologic (Varga von Kibéd and Mathka 1993, p. 58; Schiltz 2007, p. 11, Clam 2004, p. 252) or as protomathematics (Schützeichel 2003, p. 28; also cf. Schiltz 2003), while, for Spencer-Brown, the calculus of indications presents the necessary result of a consequent mathematics, the aim of which consists of: "Unlike more superficial forms of expertise, mathematics is a way of saying less and less about more and more. A mathematical text is thus not an end in itself, but a key to a world beyond the compass of ordinary description." (Spencer-Brown 1969, p. xxix).

Lau thus points out that the calculus of indications can be used to show "that logic is derivable from mathematics if one originally begins with mathematics, that is, if one formalises the simplest." (Lau 2005, p. 119)[71] The simplest here is the form of the (equally original[72]) distinction between distinction and name, that Spencer-Brown gives the symbol ⌐ . The theoretical-practical attraction of the calculus of indications consists in the fact that it "is instructive (practical) instead of assuming (ontological)" (Lau 2005, p. 17, & cf. p. 23 ff.): something comes to be designated as something in that it is distinguished from that which it does not designate. This is, in fact, simple, because in principle this already expresses everything, and so,

[70] Spencer-Brown 1969. An understandable introduction is provided by Lau 2005. A good overview of the system theoretical reception of the laws of form can be seen in Urban 2009.

[71] Spencer-Brown sees his work accordingly as an answer to that unsolved problem in the "foundational crisis of mathematics" of the relationship between logic and mathematics: "A principal intention of this essay is to separate what are known as algebras of logic from the subject of logic, and to re-align them with mathematics." (Spencer-Brown 1969, p. xi).

[72] The proximity of the laws of form to phenomenology is obvious when one summarises it in more general terms. So when Peter Fuchs explains "that which does not allow itself to be distinguished cannot be observed. Observation distinguishes (to distinguish), but it must, however, in order to make a distinction, at the same time indicate (to mark, to indicate) *what* it distinguishes. *This* is only *this* through *that*, from which it is distinguished, but *that* would be nothing without the marking (the indication) of *this*." (Fuchs 2003, p. 76).

with the calculus of indications, Spencer-Brown is articulating precisely only that which is involved in this.

This is, above all, time. For when something is designated as something, and thereby simultaneously distinguished from that which is not designated, then the "change to the other side", or, more precisely: making the distinction in that the other side becomes designated, equally presents a new operation, just as the repetition of making the same distinction presents a new operation.

It is because of this that Varga von Kibéd and Matzke can correctly describe Spencer-Brown's project as the attempt to "develop a system of *iterable* distinctions and references upon which the forming of any formal system is based." (Varga von Kibéd and Matzke 1993, p. 58, my italics). That this is so, even if the utility of this iterative moment, pointing beyond mathematics and logic in Spencer-Brown, who within his form theory assumes perfect repetition ("to recall is not to call" and "to recross is not to cross": Spencer-Brown 1969, p. 1 f.), may not itself be immediately evident (see more below).

However, the practical usefulness of his self-referential structure, and the ability of his calculus to show ways of dealing with paradoxes, is easily recognized. This has been so ever since Luhmann introduced the figure of the Re-Entry into system theory, and there played out,[73] using various examples, what it means when social distinctions on one of the two sides of the same distinction are reintroduced (that is the figure of the Re-Entry) in order to be worked upon.[74] And, it is also recognisable that the figure of Re-Entry has the ability to connect to the problem of world disclosure being followed here, in the sense that it is a work on the limits of the world, when one—bearing the social scientific usefulness in mind—quickly crosses out Luhmann's interpretation of the calculus of indications as a theory of observation.[75]

This has already happened here in that "the world" is accounted for as simultaneously the totality of the meaningfully accessible, as the totality of the distinctions between the disclosed and undisclosed, and as the object of the efforts of world disclosure, whereby the world does not serve as an unthematisable limiting concept, as it does in Luhmann, but is rather dealt with simply as something which is, like others, only accessible upon its own Re-Entry.

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[73] Already at the level of the theoretical form Spencer-Brown himself could not logically derive the figure of the Re-Entry, but rather, as he himself wrote, had to play it through experimentally (Spencer-Brown 1969, Chap. 12; cf. also Lau 2005, p. 92 ff.).

[74] One can take the paradox of education demonstrated by Kant as a simple example—how do I educate toward freedom using force—understanding the form of the school as the Re-Entry on the side of force: one cannot force a pupil to freely allow an other to finish speaking. But one can force the pupil to go to school where the teacher must then, day after day, find new ways of letting pupils finish speaking without the use of force.

[75] Here, the interpretation of the calculus of indications as a theory of observation by Luhmann is problematised by Werner Friedrichs (2008). In his re-working of the Luhmannian interpretation of the calculus of indications, Friedrichs, with the aid of Deleuze, unfolds an interpretation of form as difference in which "the *distinction* named by Spencer-Brown in the middle form [would] not be a fixed limit, but rather a difference, that would always need to be repeated anew" (ibid., p. 231)—an interpretation that here should not be once again justified, but will rather be assumed to be correct.

One can here, with the aid of the calculus of indications, understand the distinctions between the disclosed and undisclosed or, more precisely, the distinctions which constitute the ("scientific") world, and form the basis of further knowledge. This is constituted "in the world", as the Re-Entry of this distinction on one of the two sides of the same distinction. The paradox that the world is always already both: completely disclosed and completely undisclosed, thus becomes apparent as a paradox that emerges when one abstracts from time and immobilises that which can never stand still.

From a practical perspective the world is always only accessible via a Re-Entry of its constitutive distinction that has already taken place—and it is just that which renders the theoretical necessity of the abstraction from time recognisable. With that, it is no longer necessary to discredit the disclosure of the undisclosed in the name of the world's interminableness, and it becomes possible to understand the work of science as a work on the limits of the world which runs not between inner and outer, but rather inside inner and outer.

With this, it also obtains its analytical weight that it practically owns—for here, it is the limits of a *shared* [*geteilt*] world that are being dealt with. The decision as to what counts as disclosed and what counts as undisclosed can therefore only be meaningfully met in the world—and it must be made here. It is admittedly possible to provide all knowledge with the seal of the merely provisionally disclosed, or, vice versa, with the seal of final disclosure—but neither *makes* any sense, and is therefore neither conducive of knowledge, nor itself knowledge.

A distinction between the disclosed and the undisclosed must be assumed, even though it must not at the same time necessarily be explicit. As such, that which counts as disclosed should not simply include the totality of that claimed to be known, but rather what is assumed in that knowledge, including that which, due to its familiarity, is forgotten or can be forgotten. An essential part of that which can be mobilised in its disclosedness without being thereby understood appears in the form of technology.

The calculus of indications allows one at this point to formulate an analytically selective distinction between two, and that is precisely two, possible ways of world disclosure: the work on the distinction between the disclosed and the undisclosed which is directed toward a distinction copied into itself and falling on the side of undisclosedness, and the work on the distinction between the disclosed and the undisclosed which is directed towards the side of disclosedness. The former, the work on the distinction which is directed toward the side of undisclosedness, should be termed *explorativ*e in the following, and the latter, the work on the distinction directed toward disclosedness, should be termed *experimental* in the following.[76]

[76] A common misunderstanding of the logic of the calculus of indications is based upon not doing enough to ensure that, in the case of the figure of the Re-Entry, it is the copying into of a distinction falling on one of either sides of *the same* distinction which is being dealt with. The calculation is therefore itself paradoxically formulated and thus formally summarises a problem (paradoxicality), to which a solution *must* be found on the level of the social: e.g. through the dissolution of the paradox in time. There is, at the level of the social, no unresolved problem of paradoxicality. But

Just as the expedition is paradigmatic[77] for exploration, laboratory work is paradigmatic for the experiment. The former directs itself toward undisclosed, the latter toward disclosed areas. Scott and Amundsen knew as explorers that the South Pole was an untouched area, and Cristóbal Colóns daring consisted in following a previously unknown path to the East Indies,[78] while Galileo, as an early experimenter, had nothing better to prove than the previously known, and thus the correspondingly unspectacular fact that things fall down.

The former went to work disclosing undisclosed areas, while the latter disclosed the undisclosed within the already disclosed. The whole area in which Galileo's research took place should have been sufficiently well known by his contemporaries from everyday life: apples and balls, inclines, things that fall down, or roll down planks. In those days, none of these would have counted as a departure into undisclosed areas. That something new could be demonstrated presupposed the targeted production of a difference *in* the already disclosed. The production of differences where no-one imagined them to be, instead of discovering the unknown where everyone expects it to be, is the aim of the experiment in contrast to exploration.

This not only requires completely different strategies; to understand it requires a totally different way of thinking. Thus, because the attempt to disclose knowledge acquisition processes itself intends to produce knowledge, this attempt must also take on either an explorative or an experimental form—and renders the work with a logic able to deal with paradox, once more inevitable.

The exchange between knowledge acquisition processes and their reflection will later be investigated using the concept of thought systems (see Sect. 3.23). The first distinction between exploration and experiment to be upheld thus consists of the fact that exploration refers to undisclosed areas and experimentation to disclosed areas.

The work on the distinction is to be expressly understood as temporal. It is not to be understood as a spatial, zero sum game, oriented toward set theory, in which elements from the set of the disclosed are shifted into the set of the undisclosed and vice versa: in both cases, the distinction is renewed (in the radical sense of the new) in the course of the work on the distinction in each respective direction. One finds land on the Western route to India (more disclosedness), but discovers that one knows nothing about it (more undisclosedness).

One discovers that light passing through a narrow divide does not behave as one believed it should (more undisclosedness), but now knows that this is the case, and that one must take it into consideration in all that follows (more disclosedness). It is already understandable from this why making the distinction from the side of either disclosedness or undisclosedness requires *work*, while making the distinction

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there are good and worse solutions, and the most common bad solution consists in simply oscillating therein. For an account of the central meaning of paradoxicality in pedagogy cf. Wimmer 2006.

[77] In the everyday sense such as "prototypical" or "equal to a symbol", not in the Kuhnian sense.

[78] His daring did not consist in ignoring the common belief of his age that the world is flat and risking falling off its edge, as some have thought. The belief in the earth's flatness is, as Jeffery Burton Russell has shown, an invention of the nineteenth century and a recursive mystification of Columbus; in reality such an idea had not been taken seriously since the third century B.C. (Russell 1997). For a detailed account of the myth of the belief in a flat earth see also Garwood 2007.

itself (whether it be the statement that, in the end, only the undisclosed exists in the world, or the statement that, in the end, only the disclosed exists in the world) can be achieved without work, because the distinction is thus merely repeated—oscillating between the two possibilities. That is what one finds at the beginning of texts *about* science, which cannot free themselves from the fascination with the idea that nothing exists that can be declared to be finally disclosed: "The value of a call made again is the value of the call." (Spencer-Brown 1969, p. 1).

2.9 The Boundaries of the World

This all sounds like a system theoretical prelude and it is precisely not that. It is here not a matter of a system-theoretical reformulation of scientific work, with the aim of integrating the concept of *Bildung*, dismissed by Luhmann as a mere contingency, into system-theory, nor, as with Lenzen (1997), reworking it into the vocabulary of system theory until nothing remains of it.

The question as to how far this, and the following considerations, can be combined with system theory must, at this point, remain open—for a satisfactory answer would have to precede any serious attempt at combining the two, and that would require its own project.

As to whether the train of thought being followed here would allow itself to be *integrated* in system theory as it has been left by Luhmann is, however, a question which lets itself be answered with a clear answer, namely: no.[79] Insofar as the processes of world disclosure as a common moment of scientific research and *Bildung* are understood in terms of work on the boundaries of the world, then the scope of that which Luhmann presupposes, following Husserl,[80] while disregarding transcendental dissolution or the grounding in the transcendental, has already been left (without being able to step out of it into something other). This means: the understanding of sense as a fundamental medium, as the totality of distinctions between actuality and potentiality, and as a difference free concept which still refers to itself, as well as the understanding of the world as the totality of all meaningful references. Luhmann writes:

> Therefore, no sense constituting system can escape the meaningfulness of all its own processes. Sense, however, refers to further sense. The closed circularity of these references appears in their totality as the last horizon of all sense: as the *world*. The world has as a consequence the same unavoidability and non-negateability as sense. Every attempt to exceed it in thought only extends it; it [the sense constituting system—trans.] must lay claim to both sense and world and so must be that which it strives not to be. (Luhmann 1987, p. 105)

[79] In a lecture "Introduction to System Theory" held at a later point in the development of the theory, in which Luhmann makes a particular effort in the portrayal of the architecture of system theory, he expresses the suspicion that a more decisive result from the calculus of indications would enable the development of a theory which would in its universality "also even exceed system theory." (Luhmann 2002a, p. 76).

[80] Cf. Husserl 1950/1913, p. 303 f.

Sense is, in this sense, non-negateable, for "a negation would be a term, which on its part would again presume a medium which, as its most general medium, is sense." (Luhmann 2002b, p 22) At the same time, Luhmann understands the world in no way as simply being an analytical category, but rather sees it just as he does observation, as an absolutely empirical given. Thus, he writes in the *Science of Society*:

> Despite the level of abstraction of the concept 'observation', that which it denotes is meant as an empirical, hence on its part observable, operation. This has the important consequence, which goes against the grain of important assumptions by the tradition: that observation changes the world, in which is observed. In other words, there is no observable, but an observationally invariant world. Or, to reformulate it once again: the world cannot be externally observed, but rather only within itself, that is, only according to the measure of (for example, physical, organic, psychical, social) conditions which it itself provides. (Luhmann 1992b, p. 75).

Urs Stäheli has pointed out that the concepts of sense and the world (next to those of time, distinction and the unmarked state) are the difference free "final concepts" of system theory, with which Luhmann theoretically-strategically *attempts to complete* system theory, "which should save it [the system theory, SöA] from a self-deconstruction" (Stäheli 2000, p. 22). Stäheli can show that Luhmann attempts to exclude the non-sense constitutional of sense—though without him completely succeeding in that endeavour and, unlike Derrida who demonstrated with the "concept" of *différance* in what respect the possibility of sense is dependent upon its failure.

Luhmann tries to exclude the non-sense through the totality of the figure of the non-negateability of sense and the completeness of the determination of the world as the last horizon of sense: in that Luhmann, following Husserl, grasps sense as the distinction between actuality and potentiality, everything that is not yet realised still counts as sense[81] in the form of its potentiality—but, and that is crucial, as *potentially* actualisable. Stäheli writes: "For system theory they consist of surplus possibilities, which have not been actualised, but would be in essence actualisable. Sense, as such, would in no way be exceeded, but rather guarantees potentiality", and here Stäheli cites Luhmann, "always also the actuality of the world in the form of *accessibility*" (Stäheli 2000, p. 73 with reference to Luhmann 1987, p. 93 Stäheli's emphasis). Luhmann thus exiles non-sense "in a transcendental space and so at the same time rejects it as a sociological problem" (ibid., p. 75), and so not just out of the world, but out of thought, whereby he rejects all work on the boundaries of the world, or, allows them to become so diffuse through concepts such as "irritation", so that the idea of a knowledge *strategy* oriented towards the boundaries of the world, whether it be in the form of exploration, or whether it be in the form of the experiment, becomes unthinkable (on the concept of irritation cf. next section).

In this form, potentialised as it is by Luhmann, there remains "non-sense as excluded or negated […] for ever *accessible* and always available for future use, and so leaves the logic of the universality of sense untouched" (ibid., p. 76).[82] Grasping

[81] Also cf. in detail Schützeichel 2003.

[82] It must, however, be pointed out that Luhmann was no longer able to outline the consequences of a far reaching reorganisation of system theory on the basis of difference—and especially with respect to the concept of the world. However, Spencer-Brown's calculus of indications increas-

processes of knowledge acquisition as processes of the disclosure of the world would be, in this sense, senseless since, if the world, qua definition, is *accessible*, then there is nothing more to disclose, at most, all that remains is to run through it out according to the distinction between true/false. And Luhmann understands the task of science in exactly this way (cf. Luhmann 1992b). In contrast to this, world disclosure should be understood in the strong sense as a work on the boundaries of the world. And, in the strong concept of the world, the insight that one cannot step out of it and into another should be held onto.[83]

2.10 The Work on the Boundaries of the World

If one, in Stäheli's systematic manner, opens up the concept of the world for the purposes of its deconstruction, then it is possible to understand the work on the distinction between the disclosed and the undisclosed as an empirical work upon the boundaries of the world, as an always already *divided* [*geteilter*] world. One can thus understand distinguishing between exploration and experiment as, in fact, two ways of *knowledge acquisition*. The world is (and here I conceptually help myself using Jean-Luc Nancy, without further following him along Heidegger's trail[84]) always already divided [ge*teilt*] in a doubled respect:

Firstly, insofar as it is never perceivable as an undivided totality, but rather, in every meaningful phase of actualisation that an imaginary space, stretched between sense and non-sense, passes through, and so becomes divided [*geteilt*] or split. In the differential texture of every system constitutive of sense is found the movement

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ingly gained importance in his later work, while, at the same time, concepts such as autopoiesis lost their significance (for the increasing importance of the calculus of indications cf. Urban 2009, Chap. 2). In the *Art of Society* Luhmann wrote: "The consequences of a reorganisation to difference-theoretical analyses presently show themselves in rough outline, but one can suppose that they concern the concept of the world, radically changing it." (1997b, p. 48). In the same text Luhmann additionally places system theory explicitly under a "deconstructive reservation" (ibid., p. 161).

[83] In his discussion of the various ways of dealing with paradoxes in system theory and, correspondingly, deconstruction, Wimmer says that, in the case of deconstruction, it concerns neither an exceeding, nor a supersession, but rather a "distortion" of the boundary to open inwards, "i.e., that through the distinction, distinctions are constitutively explained as an outer within the inner, which would also affect the system boundary or the system-environment-difference itself." (Wimmer 2006, p. 354 f.).

[84] The division [*Teilung*] is radically determined by Nancy, similarly to *différance* in Derrida, in that nothing precedes or exceeds it. In *The Inoperative Community* Nancy thus refers to the division preceding every presence and every world as dividing all and everything: "Among us—all of us together and in different contexts—there was already a division of the common that is only its part, that, however, allows a shared [teilend] existence and so also touches existence, insofar as this means being exposed to one's own boundaries. It is that which made us 'us', us separated and bringing us near, the closeness created by the distance *between us*—'us', 'we' in the essential irresoluteness in which this collective or plural subject finds itself, damned never to find *its own* voice." (Nancy 2007, p. 32 f.).

of *différance* itself, which enables meaning, not just some division [*Teilung*] of a preceding self presence.

This meaning of division [*Teilung*] is necessarily bound up with its second meaning: that which enables significance by division [*teilend*] is itself shared [*geteilt*]. One cannot, therefore, meaningfully speak of someone having a language; rather, one must understand that one shares [*teilt*] it—otherwise one could not even begin to do anything with it. Correspondingly, one cannot as well change it, as one might wish, but neither can one avoid taking part [*Anteil*] in its changes. The world is, as such, meaningfully divided [*geteilt*] in a doubled sense: as something that does not precede this division [*Teilung*], but rather something that exists only on the basis of this division [*Teilung*], and as something that is shared [*geteilt*]. Nancy writes: "There is no meaning" (and I assume that the decisive part of the meaning of this statement can be derived from Heidegger's influence on his work and can be translated by the following):

> if meaning is not shared, and not because there would be an ultimate or first signification that all beings have in common, but because *meaning is itself the sharing of* Being. Meaning begins where presence is not pure presence but where presence comes apart [*se disjoint*] in order to be itself *as* such. This "as" presupposes the distancing, spacing, and division of presence. (Nancy 2000, p. 2)

The common reference point of exploration and experiment is therefore a shared [*geteilte*] world that must be simultaneously thought as completely disclosed (insofar as one can never pass beyond its boundaries which are thus completely disclosed) and undisclosed (insofar as one can never grasp them without at the same time missing them, insofar as no meaning can escape *différance*, which itself does not *exist*).

Exploration and experiment, as well as learning and *Bildung*, are thus paradoxical events, which can only be understood as an iterative series of incidents in which the aim is nothing less than the world itself. The paradox should thus not in this way be resolved here, in that "old European manner", (thus, transcendentally) between a world in-itself and the respectively individual, in a certain manner, "subjective worlds", in the sense of speaking of a "worldview", or "interpretation", but rather in the world—in both a resolutely material, as well as a semiotic sense[85]—which would be grasped as the last horizon of its accessibility, including its meaningful actuality and potentiality.

One can, with Spencer-Brown, form theoretically—abstracted from theoretical differentiation—describe this meaning enabling division [*Teilung*] of the world as the necessity which every denomination of a distinction must undergo: something is something always only in that it is not something else—whereby a division [*Teilung*] of the world has been introduced. If the world is grasped as the totality of all sense, and sense can only be understood as the effect of a division [*Teilung*], then this is so because it has always already been shared [*geteilt*].

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[85] Cf. Sect. 3.8. In a concise formulation Donna Haraway presents this connection so:
"Understanding the world is about living inside stories. There's no place to be in the world outside of stories. And these stories are literalized in these objects. Or better, objects are frozen stories" (Haraway 2000, p. 107).

At the same time, it is also shared [*geteilt*] because it is always shared [*geteilt*] together with others (inhabitants of the world, tourists, things, deep see animals, etc.); the division [*Teilung*] of the world is therefore radical: everything shares at the same time the same and another world—that is what *teilen* [shared/divided] means in its doubled meaning.[86] It is in this context that the concept of communication [*Mitteilung*] is to be understood (for an account of this cf. also the reference to the absent other in Sect. 3.3).

Although the distinction between the disclosed and undisclosed can only be meaningfully made within the world, the work done on the distinction presents itself as work done on the boundaries of the world, for it is always made in the form of the Re-Entry. With that, it remains in contact with just that which Luhmann attempts to exclude with his account of the concept of sense: namely non-sense. Therefore, contact is maintained to that to which no sensible reference can at all be made: which is thus neither nonsense, nor senseless, because both remain sense.

In order to be able to understand knowledge acquisition processes actually as work on the boundaries of the world, the distinction between the disclosed and undisclosed must, in this sense, be grasped as a Re-Entry of this "quasi-transcendental"[87] distinction. Every movement of research thus operates with an impossibility: it refers to something which, *qua* definition, it cannot refer to, an impossibility that must therefore be temporalised. Undisclosedness can only be established *ex post*, and described in the form of the future perfect: the reference point will have been that which has proved itself to be undisclosed (and then, however, is precisely no longer that). The movement of research itself cannot, however, meaningfully orient itself *beforehand* toward that which *afterwards* will have proved itself to be undisclosed.

It is because of this that it must either orient itself towards something that presently counts as undisclosed, but which can prove itself to be something long well known, to be something disclosed, or towards something that counts as disclosed, but which can prove itself to be something that has been undisclosed.[88] The ambiguity of the world thus shifts to the centre of its disclosure.

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[86] And so agrees with what Abdelkebir Khatibi writes about bilingualism, which Derrida then cites in his discussion of the *Monolingualism of the Other* (1998), and so, in a shared language, makes clear how much both are *divided* by their idea of a language: "If (as we are saying along with others, and after them) there is no such thing as the language, if there is no such thing as absolute monolingualism, one still has to define what a mother tongue is in its active division, and what is transplanted between this language and the one called foreign. What is transplanted and lost there, belonging neither to the one nor the other: the incommunicable." (Khatibi in Derrida 1998, p. 7 f.).

[87] Rodolphe Gasché speaks of a quasi-transcendentality with reference to such concepts from Derrida, which exceed their status as concept in their indecisiveness and, in a certain way, refer to the conditions of possibility of possibility and impossibility (Gasché 1986, esp. p. 295); Stäheli takes on Gasché's term to denote such "unities of distinctions" such as that of the unmarked state and unmarked space in Luhmann, which are, if one is exact, utterly inaccessible, "because one cannot grasp the condition of possibility and impossibility of a space of possibility once again as a space of possibility." (Stäheli 2000, p. 84 f.). Cf. a somewhat more extensive use by Rorty 1995.

[88] To say that in the present something *counts* as disclosed should not be understood so that here the distinction between knowledge and opinion would be introduced and so once again relativise the meaning of the distinction between disclosed and undisclosed for the present. The whole of that which respectively counts as either disclosed or undisclosed in the present is, after all, not a mere

However, this is not a problem crippling of research, but rather a practical one that simultaneously depicts its legitimation: it revolves around what one can term an irreducible event. Everything else (the production of reducible events) can still be science (and, seen realistically, makes up its largest part). It is, however, not insight, and so does not stand in a structurally analogous relationship to *Bildung*, which is why it is not the object of interest here.

What, however, counts as disclosed and what as undisclosed can theoretically only be redundantly formulated, or delegated as a question to empiricism: that which counts as disclosed counts as disclosed, and that which counts as undisclosed counts as undisclosed. More precisely, that which counts as disclosed is exactly that which, in future work on this distinction, can be presumed as a fact and, insofar as it is technically realised, can, beyond this, be forgotten.

The emphasis that the world, in both a decisively material, as well as a semiotic sense, is understood as the whole of its accessibility, including its meaningful actuality and potentiality, refers to, together with technology, the all too often forgotten infrastructural meaning of the concept of disclosure: before the disclosing of the sea depths through the high pressure submarine, the deep sea animal kingdom was neither disclosed nor undisclosed, but rather simply not of this world ("the world of science").

Admittedly, there was speculation, whereby the dominant view assumed a lifeless area based on the disclosed parts of the sea, the animal kingdom itself was, however, not a part of the meaningfully realisable. The surprise was correspondingly great at the quantity of life to be found at these depths. Only with the help of (preferably experimentally developed) technology was this part disclosed in its potential accessibility and (further, preferably explorative) work on the distinction between disclosed and undisclosed made possible, including further surprises (what do they look like?!!).

Stäheli refers to yet another limit of the system theoretical concept of the world, which Luhmann can theoretically secure only with great effort: namely, that which he attempts to secure using the concept of irritation. Irritation is in no place systematically explained by Luhmann, but rather always only with evocative descriptions of closely defined concepts, which Stäheli grasps as ambivalent, leftover categories of system theory:

"Irritations can be reduced neither to an external event nor to an internal observation, but rather surface in the system initially as the non-assimilable remains of that which otherwise would be thought of as its precondition." "The world," Stäheli writes, "becomes visible in a system through irritation" (Stäheli 2000, p. 45 f.) and quotes Luhmann: "It must be presupposed that the world (whatever that is) tolerates the distinguishing, and that it, depending upon which distinction has violated it, is irritated in various ways by the resulting observations and descriptions" (Luhmann 1992a, p. 93).

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opinion of the world, but rather constitutes it as that in which we have to live. For those seamen who had to die in a world without the scurvy preventing lemon juice, the undisclosedness in the area of the battle against scurvy was non-relationally decisive.

I will supplement this quote so that it becomes understandable in this context and in order to make clear how fine the distinctions which are being dealt with actually are: "The world appears, as it were, as involved invisibility; or, as well, as an indication of a disclosure only recursively possible. The world is—whatever it, as 'unmarked state' before all observation, cares to be—a temporalisable paradox […] for the observer" (ibid.).

Instead of now using the ambiguity of the concept of irritation to attempt to prove to system-theory that systems cannot be autopoetically closed, Stäheli refers (and this is what makes his argument so important) much more to the event like property of irritation, and its conceptual relation to Derrida's concept of iteration: "[T]he openness here nests within the operative event itself as a tentative connection, or a break in the following event" (Stäheli 2000, p. 45). The concept of irritation thus oscillates between its meaning as a non-integratable external event, and a moment of radical contingency, "which suspends the distinction between inner and outer and only as such throws the system into an undecidable openness" (ibid., p. 46).

In taking up Stäheli's suggestion I will return to a conceptual explanation of this moment of irritation using Derrida's concept of iteration (cf. Sect. 3.2), whereby this moment will, and need no longer, be metaphorised using the concept of irritation. It suffices, at this stage, merely to point out that the success of knowledge acquisition processes is therefore totally dependent upon the other, with whom the world has always already been shared (which, in itself, is nothing new).

The concept of the world would thus be included in the paradoxical account of the Re-Entry, without thereby according the ability to make a distinction between the disclosed and the undisclosed any functional equivalent to the transcendental subject, or assigning an objective "world in itself." It is thus possible to also say (as in Sect. 3.21 where it will be further explained) that, although we once lived, in the past present, in a world without deep sea animals, but now, since the assembled cascade of technical innovations in submarines (such as new steel alloys etc.), we have always lived in a world shared with these strange looking creatures—that is not a change in the world, but rather a changing of the world, including the past of the creatureless deep sea.

And so we can now interrogate their communications [*Mitteilungen*]—and that in the strong, material-semiotic sense of communication,[89] namely in the sense that the creatures living in the depths of the ocean were really, as was recently proved, not only already existing, but even always already had their indispensable part in the constitution of our shared world: they evidently took a part in stabilising the world climate through the effective mixing of the water layers in the world's oceans.[90] In other words, the concepts of communication and the world must be so understood

[89] See Sect. 3.3 on the communication of an absent stranger, and see p. 293 f. on the explanation of the hyphen construction "material-semiotic".

[90] This concerns the vertical mixing of different warmer and colder layers, which are crucial for the water-air heat exchange, and so for the climatic puffer function of the world's oceans. Here, it appears that jelly fish are the most important actors in the regulation of the world's climate due to their type of motion. Cf. Katija and Dabiri 2009.

that even the communications of jelly fish can be taken into consideration in a debate on climate.

2.11 The World and its Uncharted Regions

Insofar as views of science following from the conclusion about the fundamental interminableness of knowledge, begin with undisclosedness, and not with disclosedness, then they remain, it can now be specified, related to explorative processes which actually refer to the undisclosed side, while, at the same time, *everything that is thereby hidden is the starting point for reflection in the experimental sciences*. If this were not so, that exploration, as opposed to the experiment has steadily lost its importance, then one would be able to say that this is only half the truth. One cannot know, because an overarching gauge is absent, but, with reference to Europe, it cannot be utterly false to claim that it was probably once nearly the whole truth, and then (around 1700) half the truth, but today it has long been and, to a great extent, is no longer even half the truth.

If one considers the sustainability of the attention paid to it, one could view the period at the beginning of the eighteenth century as the height of exploratory research[91] (which, it might be said, reached its symbolic peak with Alexander von Humboldt's journey to America), while the experimental has, since then, steadily gained in significance.

This is, first and foremost, due to empirical reasons. Classical exploration, the journey which one undertook in order to discover the new, can have little significance in a world already largely completely covered and described. Technology becomes the (decisive) role of the catalyst of world disclosure in the form of central techniques of enablement: one must only think of the clock and the sextant which enabled the whole world to be covered in a space-time network of regulation, so that today there exists no point on the world which is not, at least in the abstract sense, temporally-spatially disclosed.[92]

Today, one would perhaps think of the airplane and the internet, which continue and refine this movement of disclosure in other forms. But formal theories have

[91] Jean-Marc Drouin sees the time of the great geographical expeditions beginning in the seventeenth century with Joseph Pitton Tourenfort's journey to Anatoly and Greece, and dates its peak at the beginning of the nineteenth century (Drouin 1994, p. 571). In this account there is also an overview of the most significant expeditions of this time.

[92] Also worth mentioning is the provision of church towers and city halls with mechanical clocks in the thirteenth/fourteenth centuries; Joseph Justus Scaliger's invention of the calendar standard time at the end of the sixteenth century, the use of which, however, was not widespread, but rather restricted almost exclusively to astronomic calculations; Sir Sandford Fleming's division of the globe into 24 time zones in the nineteenth century as well as the (Chinese) invention of the magnetic compass (first mentioned in Europe in 1187), the sextant by John Hadley and Thomas Godfrey in the eighteenth century and the circular compass in the twentieth century. For an overview cf. Boorstin 1983, as a classic cf. Mumford 1934, and, despite the continued heterogeneity in the perception of time, the very accessible Levine 1998. For the significance of the mechanical clock see also Meyer-Drawe 1996, p. 51. For the history and significance of Fleming cf. Blaise 2000.

also translated fundamental phenomena, such as movement, into closed systems of physics, so that today a simple movement no longer exists which cannot, in principle, be observed in its physical disclosedness.

Whoever wants to say something new in relation to the laws of nature must do so according to a difference to its status quo—no significant discoveries in physics, in recent times, have been won through someone braving an unknown area. Even the theory of relativity was driven, in a certain sense, by Newtonian physics—it did not come about as a description of phenomena which one could have simply found somewhere else. In this sense, the statement from Bachelard that the "The idea that we start from scratch when creating and increasing our possessions could only arise in cultural systems based on simple juxtaposition, where something that is known is immediately something that enriches" (2002, p. 24 and here Sect. 2.8) is to be understood entirely empirically.

Naturally, here too one cannot assume an originally undisclosed, and then increasingly disclosed, world (this is the *ex post* way of looking at things), but must rather assume the figure of Re-Entry, and so situate a self postponing limit (in a certain way standing alongside history) in place of a teleological development (in a certain way standing transversely to history).

For, if technological things are, on the one hand, catalysts of world disclosure, they are, on the other hand, also enabling conditions for exploration. Technical things such as faster ships, the invention of the bridle, etc., have, in the first instance, opened up an explorative, disclosable, undisclosed space.

Technological advances have so enabled sudden advances toward massive, undisclosed areas, which have enabled something like an age of exploration, or, put simply: advances in exploration. One can find concrete evidence of such advances in, for example, the globe at the beginning of the eighteenth century, i.e. that time that one could understand as the height of exploration from today's perspective. These undisclosed areas would firstly be present on this globe as uncharted regions, represented by white marks, which gradually, in the course of the disclosure of these, initially explicitly, (disclosed) undisclosed drawn areas, once again disappeared (cf. Fauser 1976). On earlier globes—and, as can be proved, and contrary to popular opinion, globes already existed 150 BC.[93]—undisclosed areas were not indicated in the form of white marks, but rather did not exist, i.e. the globes were always complete.[94]

Now, whether the "Age of Exploration" was an exception to the history of world disclosure, or whether that of the experiments was, is, in this sense, not a clearly answerable question, but it refers both to one another.[95] However, since science, at the

[93] For the history of the globe cf. Fauser 1967 and for a general history of the significance of globes cf. Zögler 1989.

[94] Before their disclosure as undisclosed these areas were shown as being covered with water, or drawn as being populated with creatures, of which one would nowadays say, that they are not of this world, such as, for example, the Antipodes, which were characterised in the middle ages as being on the south half of the globe, in which the existence of another continent was assumed, that was meant to constitute a counterbalance to Eurasia. For more, cf. von den Brincken 1992.

[95] Additionally, this here concerns, and it is also worth mentioning just to be on the safe side, a reference to, on the part of exploration, a decisively European oriented point of view, with its height-

latest, attained the niveau of a global society (cf. Luhmann 1992b), the uncharted regions on the globe have disappeared, and new space for exploration can no longer be found without more ado, but must rather be opened up through technical innovation. Thus, exploration is, more than ever before, dependent upon experimental science that is closely bound with technical development.

Today, in order to be able to explore the last uncharted regions in the classical manner, a frighteningly high expenditure must be undertaken, with an uncertain outcome. Economically speaking: the marginal utility of classical explorative knowledge acquisition strategies has been steadily eroded over the last four centuries. The sea depths, and space, represent the last remaining areas of classical exploration.[96] If one looks at the effort with which ever less knowledge is won in this way, with ever increasing expenditure, then one sees the cost of exploration exploding, and science becomes a practical joke.[97]

If the disclosure of the world has led to the fact that, today, almost no obviously undisclosed area of the world remains (which naturally does not mean the same as them being well understood, or even adequately disclosed), it is then no wonder that the experiment has, at the same time, been continually extended.[98] For, the

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ened interest in the movements of world disclosure. For an account of the difficulties of writing parallel world histories, and why it would be impossible in a work such as this see Osterhammel 2009, esp. pp. 13–24 and 1279 ff.

[96] The world of the smallest particles, for the research of which a frighteningly high expenditure is undertaken (CERN alone had available a budget of over a billion Swiss Francs in 2009), is only an explorative undertaking at first glance. In fact, a particle accelerator, due to its being tangled up in the most varied areas of research, does not let itself be represented as either one or the other, and certainly not as a homogenous field of research. A characterisation of experimental research at CERN can be found in Merz 2002.

[97] The press announcements of those in charge also—unavoidably—sound like a joke: Peter Hintze, the German air and space travel coordinator wants to apply for 1.5 billion € for a German mission to the moon. Apart from the simple spending of money (job creation) the only reason he was able to give in his announcement for such a mission was the expectation of scientific discoveries relating to by-products of the actual mission, so, on the whole, discoveries of the order of the Teflon pan, and probably then developed experimentally back on Earth bound laboratories in the accompanying research. It really concerns the creation of "high-end innovative jobs", which are supposed to drive (largely unspecified) technological development. Johann-Dietrich Wörner, the chairman of the German centre for Air and Space travel delivered the following punch line: "the moon is for us scientifically very interesting in that it hides countless secrets." (NZZ from 12.08.09) A better way of characterising the state of explorative research is barely achievable.

[98] For an overview cf. Meinel 2000. For an account of the increasing, and mostly underestimated, meaning of the experiment in the social sciences cf. Falk and Heckman 2009. One could also put forward the increasing attractiveness of the concept of the experiment as an indication of this (Berg 2009). Whether this talk of the experiment really concerns experiments in the sense meant here must, however, still be proved, above all because these can differ greatly in themselves, and can hardly be used in a theoretically adequately elaborated sense. As such, the "experimental pedagogy" from Meumann and Lays (cf. Hopf 2004) is certainly not experimental in the sense being followed here. The sense followed here is, however, closer to that of, for example, Baecker (1997), who admittedly, initially speaks only of the "experiment of organisation", but at the same time, to some extent, describes an organisational form which, with characteristics such as the targeted production of deviations, the introduction of "zones of indifference", could itself be understood

alternative to experiment and exploration with high expenditure can only consist in exploring the world further *as if* the world had not already been as disclosed as it is. However, exploration carried out in the classical form of travel then becomes tourism.

The attempt to explore a space which has already been disclosed allows science to degenerate into mere gesture. The tourist, in his/her search for those "special, undeveloped areas" (TUI catalogue 2008), twists and turns in the futile attempt to see something new, eventually exhausting his/herself in the process.[99]

The tourist who travels in order to discover something new, something s/he has not seen on television, or in the guide book, or in the nature magazine (as opposed to the holiday maker who is only concerned with having a good time in a nice place—and this means that it is especially easy to judge[100]), and only always meets the known, is a good example of the futility of the attempt to explore a largely disclosed space, not just because this is an example that can be universally understood, but also because the tradition of the expedition is to be more than clearly seen in tourism.[101]

That the analogous determination of *Bildung* as the cultivation of the natural (whether it be of the environment, or of the internal emotions), as a "reformation of unformed, primitive nature" has, with this, become invalid, has also been made the trailer for Horkheimer's, as well Adorno's, reflections about *Bildung*.

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as experimental. One could, analogous to the exemplarily reorganisation of science based upon the experimental presented here, write a history of the reorganisation of organisations from planning to the experimental, and provisionally apply the concepts developed here to the "revolution of the organisation, the reorganisation from bureaucracy and the assembly line on the basis of an open network of information, communication and production" (ibid., p. 249). Even when referring to management and planning (!) one finds the concept of experiment in use (cf. Murray and Marmorek 2003).

[99] The etymology here makes the point well: tourist derived from "tour French, foreign word. 'journey, trip, manoeuvre' (<seventeenth century). Under English influence, derived from the French tour, actually 'turn, wind', these to […] gr.teírein 'to rub, to wear down.'"" (Kluge, Etymological Dictionary of the German language, Berlin 1999, 23rd Edition).

[100] If one understands tourists as travellers whose motivation lies in the otherness of the journey's aim, then one can understand the holiday maker as those who are only concerned with finding a comfortable place. This distinction on the basis of a motivational structure is drawn from Bertram 1995, 22 ff. She distinguishes two motives: the search for something ('toward…') and the flight from something ('away from…'). The former corresponds to the tourist, the latter the holiday maker. Henning 1999 distinguishes in a similar way travellers from tourists, but so morally overloads the distinction that it becomes analytically useless.

[101] Haraway argues in a similar vein when she asks herself what nature can mean today. In no way undisclosed areas: "Efforts to travel into 'nature' become tourist excursions that remind the voyager of the price of such displacements—one pays to see fun-house reflections of oneself." (Haraway 1992, p. 296). Haraway attempts a constructive counterpart in relation to nature in her version as topos (place, communal space, nature as a place in which public culture could be reerected) and trope, whereby trope refers to turning and bending, but not as something in which one wears oneself out, but rather as a topical journey to a communal space, to nature as a public theme: "nature is a topic of public discourse on which much turn, even the earth" (Haraway 1992, p. 296; cf. also Haraway 1997a, p. 135).

Horkheimer writes of the increasingly, and, above all, almost exclusively, technically mediated, disclosure of the world, which is bringing "the traditional concepts of *Bildung*"—which can now be associated with the explorative—to an end:

> There no longer exists anything untrodden. It appears as if there was not a piece of untouched nature at all left over, neither outside nor inside […] In Europe, not to mention America, every village will soon have enough electricity and radio in order to, according to their technical requirements, in a short time, contradict what the new romantics claim to find there, in terms of being in touch with nature. (Horkheimer 1952, p. 410; cf. also Adorno 1972)

The crisis of "traditional *Bildung*" is also a crisis of the explorative.

Chapter 3
The Form of the Experimental

3.1 Open and Closed

The distinction between disclosed and undisclosed corresponds with the distinction between open and closed. For an experimenter, whose movement of research is already oriented toward an area already disclosed, the irresolvable complexity of the shared world presents a practical research problem: because of their singular eventfulness and variation, s/he can never be certain whether a phenomenon belongs to the field of the disclosed or refers to something undisclosed.

This uncertainty regarding the status of a phenomenon must be met with the reduction of the complexity of the world to the securely disclosed—as a prerequisite to being able to begin working at all. Every experiment thus begins with its delimitation to an area of phenomena considered to be securely disclosed, and the efforts of the experimenter are correspondingly directed towards delimiting a space of heightened disclosure, as opposed to the confusion of the everyday, and closing it off from the world. These experimental spaces are, however, not to be thought spatially. It simply does not concern work spaces such as the laboratory behind the closed door, but rather concerns existing knowledge, which acts as a fixed prerequisite and is sedimented in "technological things."[1]

Rheinberger clarifies: "Spaces of representation are coordinates of signification. They are opened, as well as limited, through the technicalities of the system. They disrupt the immediacy of the presence of a phenomenon by rendering it as a mark" (Rheinberger 1997, p. 105).

While exploration could be undertaken in open spaces, because exploration begins at a distinction between the disclosed and the undisclosed existing in the world itself, and the first step consists of entering an undisclosed area in the world, the experimenter's initial step is complementary to that, and consists of closing off a space, right up to the limit of total disclosedness, in opposition to the world.

This is also valid for social space:[2] Boyle could never have demonstrated anything if he had not drawn a social distinction between "those out there", who could only speak for themselves, had nothing other than opinions, who, where possible,

[1] This is a jump ahead. The concepts "technological thing" and "epistemic object" will be more closely explained in Sect. 3.6. Cf. also Sects. 3.17 and 4.3.

[2] A fact that could be forgotten since science, in the course of its differentiation, provided itself with its own internally generated criteria of exclusion and is only reminded of it by the feminist

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would produce phenomena, like magicians, for the sake of effect, and the trustworthy gentlemen "in the laboratory", who only spoke for nature, who were able to thereby leave themselves completely out of the matter and, instead of stating opinions, were able to bear witness.

Naturally, this social distinction does not coincide with the physical space of the laboratory; it even runs through the gentlemen themselves, who must be able, in the presence of their most inward, to leave it outside. In the beginning, Boyle allowed the general public as audience (not as witnesses) to his experiments, even women and children were present. Visitors are also today guided around CERN, there are open days in research institutes, and similar events. However, this is all only possible because the separation between "inner" and "outer" has so well established itself that the mere presence of outsiders cannot endanger the distinction.

Boyle, however, had actually to fight with emotionally uncontrollable women, who tried to free the suffocated bird from its glass globe, and saw himself, for that reason, obliged to postpone his experiments until late in the evening, when ladies no longer took to the streets.

Just as important as the social separation between inner and outer is the concrete epistemological side of this distinction; experiments are only possible if a specific, material-semiotic field is distinguished from the rest of the world. Naturally, the distinction here, too, does not coincide with that of the laboratory, but is rather a historical product of the research itself.

Sometimes, the distinction between inner and outer runs along the edge of the Petri dish. It was only because not every single spore floating in the air in Alexander Fleming's laboratory was able to have a go at his staphylococci, i.e. they were kept outside, that the penicillin, clinging unasked on the inner side, had a chance to make itself be known, to make a difference.

Sometimes, the boundary also runs beyond the walls of the laboratory, and still creates a sufficient separation between inner and outer, e.g. when the ships observed by von Lind, with their scurvy afflicted sailors, sailed across the oceans, they took the boundary with them in the form of their railings, so that together, although spread over the oceans, they created a space closed to the world.

Rheinberger terms such a space, shut off from the world, an "experimental system" (which should not be understood as a system-theoretical concept), and understands these, with reference to the experimenters themselves, as "the smallest integral working units of research" (Rheinberger 1997, p. 28) in experimental science. Experimental systems are thus not seen by Rheinberger as merely a part of a superordinated whole, but rather, in a strong sense, as the source of the new in science, so that, in his research into the history of protein synthesis in the test-tube, he could establish "that the origin of molecular biology goes back to a multitude of smaller working contexts, the actors of which often referred to as their experimental systems or model systems or simply as their systems" (Rheinberger 2007). The new therefore consists "less in the heads of the scientists—where it, however, must finally land—as much more in the experimental system itself" (ibid.).

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critique of science with reference to the remnants of non-internally generated criteria of exclusion. For an overview cf. Scheich 1996.

What is not seen in a tradition of the philosophy of science forgetful of the material and the technological is that the decisive move at the beginning of an experimental work does *not* consist of the choice of a theoretical space of reference (or some other *observational instrument*), but rather in the division [*Teilung*] of the world, the de-partmentalising of a world, heightened in its disclosedness in the world, through drawing a boundary between the inner and outer of an experimental system.

It is a mistake drawn from explorative thought that the first step is *always* the choice of a theory, or an (other) observational instrument. This assumption is, however, still today dominant across the whole of propaedeutics, regardless of discipline. The belief that it is also valid for experimental research is based on the explorative thought of the experiment as a tool of falsification (see here also Sects. 3.2 and 3.4.)

What Rheinberger describes in detail in his research into the history of protein syntheses in the test tube is the effort and difficulty that the choice, construction and maintenance of a "good system" bring with it. The fact that experimental scientists do not constantly move to new laboratories every time that they want to find out something new (an idea of those who believe that the apparatus are tools of explorative knowledge acquisition), but are rather stubbornly devoted to their familiar apparatus,[3] expresses to what degree the direction of experimental research, as opposed to exploration, is focused *inward*, rather than *outward*:

> [T]he more he or she learns to handle his or her own experimental system, the more it plays out its own intrinsic capacities. In a certain sense, it becomes independent of the researcher's wishes just because he or she has shaped it with all possible skill. (Rheinberger 1997, p. 24)

Rheinberger took the concept of the experimental system from biological research praxis—not from scientific theory and not from knock-off philosophers either. It is the researchers who speak among themselves of their "system", as does Mahlon Hoagland who, in her scientific autobiography, speaks of the "selection of a good system as a key to success on the 'itinerary into the unknown'" (quoted from Rheinberger 1997, p. 19) and thus pointedly shows the inappropriateness of the explorative metaphor of an 'itinerary into the unknown' when contrasted to the bound space associated with the "selection of a good system".

The experimenter does not simply direct his attention *more* toward the disclosed than to undisclosed areas, but rather begins with the disclosed, and dedicates much of his/her work to the effort of artificially stressing this separation and pushing disclosedness *up to the boundaries* of the fully known. S/he spends much effort in constructing a system from which the environment is so well excluded that s/he has the chance of comprehensively understanding, and becoming acquainted with, what takes place on the inside, or being able to forget it as known knowledge, while still being able to utilise it. As such, writes Rheinberger, experimental systems are "[actually] machines for reducing complexity" (2001, p. 247).

[3] This observation is repeatedly made by Rheinberger at the beginning of his analyses: cf. Rheinberger 1997 p. 24 ff., 1992, p. 9 and 2005, p. 61 f.

The system fulfils its function so much the better the more closed, and the more disclosed, it is. And, it can fulfil its function so much the better the more the experimenter is acquainted with it. This is valid up until the limits of perfection. Rheinberger writes, "Experimental systems are inherently open arrangements" only in apparent contradiction to what he writes elsewhere (2007, p. 57).

The difference to exploration in "open space", which will here be opposed to "closed space", consists in that, in an open space, the borders fray into uncertainty, and a field of certainty is created around the explorer, while in the "closed space" of the experiment, it is precisely the "borders" (which can no longer be thought of as simply spatial, as circumscribing a space),[4] that become "closed" through technically improved certainty, in order to allow effective insight into the inherent interminableness. Understanding in the experimental is, therefore, not concerned with taking the open horizon into view, but rather with the "opening of the world", as Rheinberger expresses it, with a phrase taken from Althusser, "to think toward the event" (2001, p. 144).[5]

This inherent openness of the system closed up until the limits of perfection (and simultaneously operating on the edge of a collapse: ibid., p. 146),[6] distinguishes the experimental system from simple technology, such as one finds in the form of aged[7] experimental systems, no longer suited for experimentation.

Whoever today, like Boyle, asphyxiates a bird with an air pump, is no longer experimenting with an experimental system (strictly speaking, an experimental system is characterised as such in that one cannot experiment *with* it); s/he is simply using a bird asphyxiation machine—even if one were dealing with one and the same piece of apparatus.[8] One and the same piece of technical apparatus is thereby put into use, once in a decisively non-technical fashion, and once in a decidedly technical fashion, in other words, just as a tool (for an account of this see Sect. 3.17).

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[4] The same is valid of the "margins" of the experimental system as that which Derrida demonstrated in his discussion of Austin with reference to context: it can never be absolutely determined (Derrida 1977).

[5] "But to accede, if this is possible, to the event beyond all calculation, and therefore also beyond all technics and all economy", Derrida programmatically says, " it is necessary to take programming, the machine, repetition, and calculation into account—as far as possible, and in places where we are not prepared or disposed to expect it." (Derrida in: Derrida and Roudinesco 2004, p. 49).

[6] Strictly speaking: an experimental system breaks down when it can only be repeated without productive deviation, only used as a tool, or drifts into the chaotic and can no longer be recognisably repeated. This swing between two sides, which can only be maintained in time, describes the temporalising character of a Re-Entry, and is also found in other contexts: cf. Ahrens 2006.

[7] "The age" of an experimental system, writes Rheinberger, "is measured by its capacity to produce differences which allow questions relevant to the research to be put" (Rheinberger 1992, p. 51). According to Rheinberger, experimental systems possess an "inner time", which is characterised by "a succession of system states, insofar as these can be grasped in the form of cycles of non-identical replication. The research systems which are here concerned are exactly those characterised by a type of differential reproduction, in which the production of the unknown becomes the reproductive principle of the whole machinery. As long as this occurs, the system remains 'young'. Being 'young' is, therefore, not the result of the proximity to the starting point on the timescale: it is much more a function—if one will—the functioning of the system." (Ibid.).

[8] This is another reason why technology is impossible to essentially determine.

3.2 Space and Time

> iter, again, probably comes from itara, other in Sanskrit, and everything that follows can be read as the working out of the logic that ties repetition to alterity
>
> —Jacques Derrida 1777, p. 7

Everything in the following can also be read as an exploitation of that logic which binds repetition with otherness.[9] Whoever searches for something unknown in open space, finds it, observes and describes it, must fear that this unknown evades its description, or that it, from another angle, presents itself in another light than originally thought, so that the fact believed to have been discovered actually turns out to be a mistake.

In contrast, whoever closes off space up until the limits of perfection, so that nothing remains that can be determined as being undetermined, that evades the disclosedness of his/her knowledge, must not fear this moment of alterity in time. On the contrary: s/he must hope for it. As soon as s/he is surrounded by what s/he is familiar with, then s/he searches for the unknown not in *someplace other*, but rather traces the unknown on the spot, in the hope that it will *at sometime* show itself.

Exploration as a primarily spatial matter traditionally meant simply the prospecting and exploration of previously unexplored areas. Exploration is poor in prerequisites, and belongs to the standard repertoire of even the smallest children (see Mönks and Lehwald 1991). Previously unknown regions are explored, areas that were, until a particular time, too far away, too inhospitable or too small.

Therefore, the next difference between the two knowledge acquisition strategies that should be upheld is that experiments produce their differences less through movement in space, but rather primarily in time. Here, differences are shown, not between here and there, but rather between one time and another. Galileo was meant to have let his spheres roll down an incline hundreds of times, before what was to be shown was actually shown. Again and again, the physicists in CERN let particles smash into each other.

Always repeating an experiment each time, with only the slightest of changes, ideally so minimal that they cannot be consciously produced, but rather undermine the intentions (see Sect. 3.13) of the experimenter,[10] is the means of the experimental production of difference, the strategic exploitation of the iterability of every signifier.[11] Strictly speaking, the entire understanding of the irreducible, material-

[9] A more precise description of the relationship between iteration and alterity, spatialisation and temporalisation, than can be given here without overstepping the scope of this work must result from a reconstruction of Derrida's discussion of Husserl. As an exemplary alternative, cf. Maxim 2009, pp. 179–229.

[10] This formulation needs to be further refined: for if the relationship to experimental institutions was drawn then it is neither the provisionally pragmatic formulation taken from the close lying active engineering form (the experimenter undertakes targeted changes), nor the blind "trial and error" which one could interpret here. See also Sect. 3.18.

[11] This context is only understandable if one at the same time desists from applying the explorative job of representation (cf. Sect. 3.8) to the experiment, and takes a step back from the attempt to

semiotic constitution of the world is already contained in this formulation.[12] If one assumes the traditional distinction between signifier and signified—a distinction which thrives on the confusion of the world; from the disorder on the side of that which is identified as non-signified—then it would not possible to think that the theories and concepts in the practical experiment are involved in the games of iteration played between the heterogeneous human and non-human actors (cf. Latour 1999b, p. 174 ff.) in the material-semiotically constituted experimental system.

For Hobbes, who tried to defend philosophy's claim to truth against its abuse from those who, full of arrogance, covered themselves in the mantle of the philosopher[13] while making do with probabilities—certainly something which clearly does not *correspond* to the truth—the necessity of repeating an experiment demonstrated, beyond any doubt, its unreliability.

For, if the experiment did correspond to the truth, then a single run would undoubtedly suffice. As a scientist, or even as a philosopher—thus as a lover of truth—one cannot simply keep trying until something works as one sees fit! And, even today, this idea finds its negative application in the misunderstanding of the experiment as an instrument of falsification, or in the exemplary ideality of an *experimentum crucis*.

One single time must be sufficient, if one does it correctly,—now negatively applied—to prove a theory wrong. There is hardly a single introduction to the work of science in which this is not especially emphasised: one single time is sufficient to refute a theory. And that is even true: a single time is sufficient for a refutation. This, however, does not concern an experimental knowledge acquisition *process*, and also concerns only a moment within an explorative knowledge acquisition process. Within this, the essential details, such as, e.g., the not unimportant question as to how one actually had the idea to be falsified (or had the idea to falsify, or had the idea to falsify just this, and not something else in just this manner, and not in another way),[14] remain totally obscure (i.e. do not refer to the process). Additionally, this "single time" takes place, as a rule, at the end of a whole sequence of attempts at identifying the source of failure, excluding other possible sources of error, and efforts to explain the failure with the help of various theoretical modifications.

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universalise the experiment on its behalf, but rather, instead, to put the necessity of (intertextual) translation in place of the representation (cf. ibid.). All this is already contained within the concept of iterability: "the iterability of the mark does not leave any of the philosophical oppositions which govern the idealizing abstraction intact (for instance, serious/non-serious, literal/metaphorical or sarcastic, ordinary/parasitical, strict/non-strict, etc.). Iterability blurs a priori the dividing-line that passes between these opposed terms, 'corrupting' it if you like, contaminating it parasitically, qua limit. What is re-markable about the mark includes the margin within the mark. The line delineating the margin can therefore never be determined rigorously, it is never pure and simple. The mark is re-markable in that it 'is' also its margin." (Derrida 1977, p. 70).

[12] Cf. Haraway 1997a and here Sect. 4.7.

[13] And that is not just meant metaphorically, but also absolutely literally: for an account of this see Sect. 3.21.

[14] It is systematically and explicitly excluded: Popper writes pointedly in *The Logic of Scientific Discovery* that we do not know, but guess (1972/1932, p. 278).

"What would have happened if Copernicus had been a heroic falsificationist?" asks Isabelle Stengers and provides the clear answer herself: "A disaster, for he would have heroically abandoned his heliocentric position, which was refuted by the fact that the theory implied that Venus had phases like the moon, something that astronomers had never observed" (Stengers 2000, p. 32). The falsification model, as a model for the experiment,[15] remains rooted in the thought system of exploration and, at the same time, brings it to its limits.

Within this thought system, one must understand it as a last attempt to provide an answer to the increasing symptoms of crisis of just this very thought system. This was not apparent to Popper, for he believed that, as a theoretician of science, working exploratively, he stood outside that which he described.[16] He thought that, by raising his descriptive model of science to a criterion of science, he was thus able to render himself resistant to falsification in the face of empirical discrepancies.

Feyerabend became increasingly conscious (as opposed to e.g. Lakatos, who worked on salvaging the logic of research[17]) that this was not working, and came to the conclusion that every attempt to engage in the philosophy of science by beginning with theory was nothing more than killing time.[18]

Today, because these attempts can be seen to be attempts at salvaging an explorative thought system, claimed to be universally valid, which finds itself in crisis, one can trace the connection between Popper to a philosophy of presence, which the explorative research movement, with its aim of establishing facts as a schema of reflection, harmonically accompanied and completed (cf. Sect. 3.8).

And, still today, one finds voices who claim that one cannot do without some sort of founding criteria for science, oriented toward a philosophy of presence, at least in the form of the possibility of being able to fail when faced with reality. After the presence oriented reflection of science was firstly expelled by Boyle to the sidelines of the main event, and after a few rounds of shadow boxing with itself in the form of the theory of falsification, it stood with its back against the wall. That it still remains true to presence, even in this negatively applied form, becomes clear at the very latest when one tries to more closely consider the meaning of technology in the process of research: one is unsuccessful when one insists upon thinking in terms of presence (also Sect. 3.4 and Ahrens 2005).[19]

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[15] There is falsification just as there is exploration. But falsification is not *the* model for the experiment; understanding the experiment as a means of falsification would mean misjudging its ability to generate insights and thereby degrade it to being just a means.

[16] See Sects. 3.21 and 4.6.

[17] Above all, cf. Lakatos 1982 and, for a systematic overview, Andersson 1994.

[18] *Killing Time* in the original is the title of his autobiography (Feyerabend 1995), in which Feyerabend, for one last time, points out that the principle of falsification is an exception and not the rule: "Practiced with determination and without subterfuge, the doctrine of falsifiability would wipe out science as we know it. There are a few episodes that seem to conform to the falsifiability pattern […] But the great majority of episodes, and especially those which, according to Popper, show science at its best, developed in an entirely different way." (Ibid., p. 90 f.) On the falsification of the idea of falsification cf. Feyerabend 1975.

[19] This is, therefore, not about accusing Popper of being inconsequent, as did, for example, Albrecht Wellmer when he proved that Popper—against his actual intention—uses the (allegedly)

Hobbes saw his critique of the experimenters, with their inadequate claims for a secured truth, and their tendency to make do with probabilities, further confirmed by their careless use of language. After all, it was only a language schooled in geometry and logic which could be in a position to guarantee truth.

Today, from the perspective of philosophy, it was not so much Hobbes' underestimation of the efficiency of the experiment which draws attention, as rather his overestimation of the possibilities of language. For, the possibility of language expressing something true does not rest on the principle of correspondence, but rather on the principle of iteration.[20]

If the following concerns iteration, then not as another contribution to the crisis of representation, with the aim of once again criticising the philosophy of presence in another way, or by referring to texts not yet criticised, proving that iterability is necessarily bound to alteration and, therefore, no presence can be definitively *established*. It much more concerns retracing the strategic use of iterability in the experiment. This means in situations that are involved in the invention of conditions in which an absent unknown has the chance of making itself known (see Sect. 3.3).

Iterability in itself is nothing that one could rely upon, especially not when concerned with technology. For technology *functions* in the form of ideality—it is built in order to be endlessly repeated, without any recognisable deviation—and if it is not able to do that then it is mostly broken.

Harnessing it [technology] within an insight bearing, iterative event thus presupposes exceeding its functionality (without breaking it) and involving it in a non- or, more precisely: not completely technical context. In other words, until now, the potential of alterity within iteration has, above all, been pointed out from an analytical perspective, in order to hold open possibilities for the thought of change. What, however, experimenters do, is something different: they strategically use—without necessarily being able to theoretically account for this—iterability in the scope of world disclosure processes, and increase the probability of the iteration producing insight through the use of technology.

In this sense, experiments are not secondary to knowledge acquisition processes, as Popper thinks.[21] Rather, they are themselves, as it is expressed in a phrase from François Jacob: "machines for producing the future" (quoted from Rheinberger 1992, p. 53)—presupposing that one understands them to be machines which are thought until their limits (cf. Stiegler 2009a). Rheinberger's description of the experiment is a reformulation of the work of natural science as iteration, as differential

"metalogical" argument of falsification ontologically (Wellmer 1967, p. 233) or to show that Popper partly understands the truth classically and explicitly as "correspondence with the facts" (Popper 1969, p. 224).

[20] For a retrospective overview of correspondence theories cf. Marian 2009.

[21] Popper is here only the prominent name which stands for this view. If one wished to remain in the area of theories of *Bildung* one could, for example, also name Theodor Litt, who in one place writes: "the experiment is for the purpose of testing a hypothesis, and is thus an *act* on nature, of purely theoretical intent. […] The experiment is the theoretical anticipation of technology, technology is the experiment adopted in praxis." (Litt 1957, p. 61).

reproduction on the level of technology and life itself, which never simply *is* and could be observable as such.

This is nothing new, but also certainly not just the same as if one entered the laboratory and repeated the known in this context.[22] So, when Derrida writes: "The play of differences supposes, in effect, syntheses and referrals which forbid at any moment, or in any sense, that a simple element be *present* in and of itself, referring only to itself" (Derrida 1972, p. 23), then this really symbolises biology, especially when radioactive isotopes are used in radio-labelling, in the process where single atoms in molecules are replaced by radioactive isotopes, but appear as a trace only in the moment of their decay.

But this is more than a symbol, since the laboratory itself is the level constitutive of meaning. That no element can ever have the function of a sign, "without referring to another element that is itself not present, whether this be in the area of speech or of that of written language" (ibid.), is also valid for elements of an experimental system. This is why it concerns a translation (see Sect. 3.8), and not an act constitutive of meaning when the events of an experiment run into scientific texts or even laboratory books:

> This interweaving results in each "element"—phoneme or grapheme—being constituted on the basis of the trace within it if the other elements of the chain or system. This interweaving, this textile, is the text produced only in the transformation of another text. Nothing, neither among the elements nor within the system, is anywhere ever simply present or absent. There are only, everywhere, differences and traces of traces. (Derrida 1972, p. 24)

There is no talk of a corresponding shift in paradigm in Rheinberger, but rather of just such transformations: "the breakthroughs I am describing lie in the disseminating power of epistemic things that eventually became transformed into technical things" (Rheinberger 1997, p. 35). It is because of this that the work in a laboratory also does not primarily consist of observation, but rather in the iteration, in the repetition aimed at difference. "This does not simply mean that they must allow differences to occur; they must be organized in such a way that the production of differences becomes the reproductive driving force of the whole machinery; the system, then, may be said to be governed by *différance*" (ibid., p. 224).

This description does not become less correct when one adds that the final aim of an experiment is the stabilisation of constancy.[23] It almost goes without saying

[22] Repetition is found here too: a part of this and the following section have already been published (Ahrens 2009, pp. 37–44) in a slightly altered and recontextualised version in the context of the question of the potential for insight in cinema. This article also served to demonstrate the potential of the concept of the experiment beyond the narrow focus of *Bildung* with reference to natural science and technology, in the example of media pedagogy, or, more precisely, cinema *Bildung*.

[23] As Stichweh writes, the distinction between difference and constancy is itself "encroached upon" (Stichweh 1994, p. 294) by the concept of difference, already because—and here Stichweh argues system theoretically—"constancy also constitutes a difference to the expectation of the contingency of the event. Constants are therefore to be understood as informative differences—in the sense of the Batesian definition of information as a 'difference which makes a difference'" (ibid.). For an account of the general relation between unity and difference in scientific systems cf. Stichweh 2007.

that, on the way to this goal, the whole "machinery" is neither determined by mere chance, nor may it be completely technological.

It was said that exploration is *primarily* a matter of space, insofar as the strategies of the explorer are always aimed toward space, and experiments are *primarily* a matter of time, insofar as the strategies of the experimenter are always aimed at a succession of experimental runs. However, at the same time, a knowledge acquisition process is never *only* a matter of space or of time: that movement in space is also always movement in time goes without saying.[24]

In this respect, exploration is an easily understood matter. That experiments are primarily a matter of time because they must be repeated and repeated, is also easy to understand. However, if one considers the experiment more closely, as "governed by *différance*" (ibid.), and a "machine for creating the future" (Rheinberger 1992, p. 53), in which nothing, "neither among the elements nor within the system, is anywhere ever simply present or absent" (Derrida 1972, p. 24), so that one "[must] maintain that différance (is) (itself) other than absence or presence" (Derrida 1982, p. 23), then one can only understand the experimental system when one thinks its temporalisation simultaneously with its spatialisation:

> It is because of *différance* that the movement of signification is possible only if each so-called "present" element, each element appearing on the scene of presence, is related to something other than itself, thereby keeping within itself the mark of the past element, and already letting itself be vitiated by the mark of its relation to the future element, this trace being related no less to what is called the future than to what is called the past, and constituting what is called the present by means of this very relation to what it is not: what it absolutely is not, not even a past or a future as a modified present. An interval must separate the present from what it is not in order for the present to be itself, but this interval that constitutes it as present must, by the same token, divide the present in and of itself, thereby also dividing, along with the present, everything that is thought on the basis of the present, that is, in our metaphysical language, every being, and singularly substance or the subject. In constituting itself, in dividing itself dynamically, this interval is what might be called *spacing*, the becoming-space of time or the becoming-time of space (*temporisation*). (Derrida 1982, p. 13; cf. also Derrida 1972)

If, in an experimental system, "the proliferation of differences becomes the foremost reason for its own continued activity" (Rheinberger 2005, p. 70), so that one can say "that the system is permeated with *différance*" (ibid., p. 244), then that does not only mean that one must understand experimentation as an event.

Rather, it also means that one can only understand experimental systems when one has taken everything into account that is mobilised with it, and sees the whole experimental system, including the apparatus, instruments, tables, organic material etc. as a "configuration of traces".

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[24] Today, at this point, the quantum entanglement described by Einstein as a "spooky long range effect" is reflexively put forward as a counter example, which possibly occurs without delay, but at least at 10,000 times the speed of light (this minimum speed is the result of calculations from Salart et al. 2008). That is, after all that one knows from the form of such a proof, nonsense, then, firstly, in the quantum teleportation nothing is transferred and secondly, nothing that one could call information or material. Significantly, in quantum teleportation the possibilities of its application are far more developed than the theory.

That means that no element (grapheme) in an experimental system stands there in isolation, and that it gains its meaning only in its demarcation to all other elements: "Whether the traces that are produced in an experiment will prove 'significant,' depends on their capacity to become reinserted into the experimental context and to produce further traces." (Rheinberger 1997, p. 107)

Although this is a general principle because nothing can yield signification effects in isolation, it is only in the experiment that this principle is exploited for the strategically aimed production of differences intended for insight. Here, the collected things are brought into such an intimate context, are coupled to one another so narrowly (but not so narrowly that it becomes completely mechanised and only functions as a machine), that they are able to, from their innermost, draw out the "state of research" expressed in this construction. (This does not concern just any constellation, but rather a specific interrogative arrangement).

This does not mean that the person of the experimenters is insignificant, but s/he is no longer the middle point of the events (see Sect. 3.21). S/he is certainly not the sole author of the text to be written. As such, s/he is less (if one wishes to maintain this image) a de-scriptor and much more an in-scriptor and tran-scriptor, as well as being the one who tries to maintain a "space of vagueness" (Rheinberger 2001, p. 249), which neither tips into the machinelike, nor drifts into clamour, whereby s/he can in no way always have everything in view:

> Producing traces is always a game of representation/depresentation. Every grapheme is the suppression of another one. Enhancing one trace inevitably means suppressing another one. In an ongoing research endeavor scientists usually do not know which of the possible traces should be depressed and which should be made more prominent. (Rheinberger 1997, p. 112)

If one now considers the experimental system itself not as its own, autonomous world (which it is not, and also could never be[25]), but rather as a growing relationship of world disclosure and closure in the world—and that in a world full of experimental systems, full of things introduced into experimental systems, and extracted from them, full of the results of experimental systems which have become products and technologies—then this spatialisation extends further, namely, up until the boundaries of the shared world itself (which is also divided [*geteilten*] by the boundary of the world shared [*geteilten*] by the experimental system).

No experimental system can, therefore, be thought of as being separated from other experimental systems and the world, and must be simultaneously thought exactly so, as being separated from the world, just as there is no single language for anybody, and simultaneously never more than one.[26] Thus, it is not only the ele-

[25] The empirical evidence of "environmental influences", insofar as evidence is needed, can be found in Collins and Pinch 1982; Shapin 1979 and MacKenzie 1978.

[26] "1. We only ever speak one language. 2. We never speak only one language." (Derrida 1998, p. 7) This is, of course, not Derrida's conclusion, but rather simply the starting point of a detailed discussion of the relation between a native and foreign language, which is escorted by the question of the inner non-identity of a language: "No such thing as a language exists. At present. Nor does the language. Nor the idiom or dialect. That, moreover, is why one would never be able to count these things, and why if […] we only ever have one language, this monolingualism is not at one

ments within an experimental system that refer to each other, but also the experimental systems themselves, within a more comprehensive texture:

> It is the network of surrounding experimental systems that makes each of its elements take on its epistemic value. If ontical complexity has to be reduced in order to make experimental research possible, this very complexity is *epistemically* retained in the rich contexture of an experimental landscape in which new connections and disconnections can happen at any time and where the eruption of one 'volcanic system' can change the whole landscape, through passage and propagation. (Rheinberger 1997, p. 227)

Here, Rheinberger uses the metaphor of the patchwork: "The patches, that is, the experimental systems are the subcritical elements of a network that, as a whole, takes on the features of a supracritical process we call science in the making." (Ibid., p. 228)

3.3 The Other and its Absence

Whoever speaks of experimentation in the sense of a "free", "playful", and "creative" process (cf. Sect. 2.2), misses not only the character, but also the purpose, of every form of experimentation. What makes the experiment a serious matter is, however, not its alleged "controlledness" or its strong "methodicalness", but rather the communication [*Mitteilung*] of an absent other [*Fremden*], which needs to be sought out.[27]

The outcome of an experiment is anything but a matter of a free choice, and its utterly non-playful course does not orient itself according to the creativity of the experimenter. The success of an experiment depends upon an other,[*Fremden*] which,

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with itself." (Ibid., 56) Koller points out that one also finds in Humboldt, even if it is embedded in a harmonising teleology, this moment of irreducible difference. Namely, there where Humboldt deals not with the restrictive differences of national linguistic boundaries, and emphasises that every person speaks their own language, which is why all understanding is "therefore, at the same time a non-understanding" (Humboldt quoted by Koller 2009, p. 42).

[27] Also cf. the point made about division [*Teilung*] in Sect. 3.10. Communication [*Mitteilung*] will always be used here, and in the following, in its double meaning: as communication, as articulation in the sense of a making-itself-known, and as co-mmunication [*Mit-Teilung*] in the sense of a sharing of the world, of being-involved; both belong necessarily together. The attempt to always do justice to the division [*Teilung*] of the world always presupposes that the world is shared [*teilen*] in such a way that the communication of those with whom we share [*teilen*] the world is understandable; this therefore always concerns co-mmunication (in) the world, not immediately the communicator him/herself. As to whose communication it is should not be decided beforehand. This is in the interests of a "symmetrical" (Latour) access and to avoid an epistemologically problematic anthropocentrism. This does not, of course, mean that all communications have to be viewed as equal, or could be at all—in fact, it is just that division [*Teilende*] that makes every communication necessary and the consideration of all communication impossible. The talk of communication should also not evoke the idea of a pre-existent entity. It can just as well be about a communication from another person as an experience repressed by one's own unconscious or the communication of something so trivial such as air pressure. What is decisive is its function in the context of the processes of world disclosure.

in its absence, is not just the cause of the attempt to give it the possibility of communicating its disclosure, but is also that which distinguishes the aimless process of experimentation from the contingency of mere trial and error. More precisely: the process of experimentation is at the same time qualified by the absence of a purpose, as it is distinguished by its purposefulness.

While the distinction between the disclosed and undisclosed relates to the divided [*Geteilte*], the distinction between ownness [*Eigenem*] and otherness [*Fremdem*] refers to the divider [*Teilende*]. The other [*Fremde*], as the co-mmunicator [*Mitteilende*], is the undisclosable, par excellence.

If one reduces and abstracts the problem of the other [*Fremdem*], while ignoring all other possibilities to grasp it in its paradoxical form—as something foreign [*fremd*] it lies beyond one's own possibilities of experience, but it is only within one's own possibilities of experience that one can experience something as foreign [*fremd*]—then it can be brought into a relation with the distinction between the disclosed and undisclosed being followed here.[28] It is without question that in doing so we cannot deal with this subject with the same depth of differentiation accorded to it by others.

Even the different forms in which the paradox of the experience of the foreign [*Fremden*] can be thought cannot be listed here, let alone singularly discussed (cf. Wimmer 2006). That the problem of the other [*Fremden*], when one thinks it sufficiently consistently through, inevitably leads to a paradoxical form must, however, not be once again demonstrated, but can rather be presupposed as conscious knowledge.

As such, for Waldenfels, the paradox is the Skandalon, which is at the centre of the problem of the other [*Fremdem*]: "[The] radically foreign […] lets itself be thought only as a paradox, which clothes itself in formulae such as 'the accessibility of the inaccessible', and 'partisanship in the nonpartisan'" (Waldenfels 2002, p. 188; also cf. Sect. 2.7 and Waldenfels 1997, ch.1). Placing the paradox at the centre of this thought, instead of avoiding it, is what first of all allows the problem of the other [*Fremden*] to be translated into an abstract theory of world disclosure at all—bearing in mind that the problem is thereby neither solved nor processed, not even differentiated, but rather merely receives a form in which the problem remains in theory recognisable as a practical challenge for the praxis.

The figure of the Re-Entry is analytically particularly fruitful when applied to the version of the paradox chosen here, with the aid of Spencer-Brown's calculus of indications, because, with its help, a problem which, in reality, does not exist, can be formulated as a paradox under the abstraction from time. The problem does not exist "in reality" because paradoxes can never exist in the world and time, but are rather always only available as (re-)constructions, and under the abstraction from time.

[28] Thus the other [*Fremde*] is here thematised only from the perspective of the exploration of the world. But, of course, one meets the unknown not only in the course of the processes of world exploration. It does not even think to wait to see whether one is interested in it and keeps trying to intrude one's space even when one doesn't need this at all.

That a paradox cannot exist in the world is still a long way off from saying that it does not present a problem. It is precisely because a problem cannot exist in the world as a paradox that such problems exert an unavoidable pressure to act. The analytical gains of this perspective consist in being able to compare the functional equivalents of available solutions to a given paradox, through the (re)construction of the appropriate problem.[29]

As such, the analysis does not run the danger of oscillating between existing solutions, or having to dismiss itself to the imaginary, or committing to a certain solution on the theoretical (i.e. the wrong) level (also see below Sect. 4.7). Within the figure of the Re-Entry, the fact is taken into account that the quasi-transcendental distinction between the disclosed and undisclosed, and the corresponding distinction between ownness [*Eigenen*] and otherness [*Fremden*], cannot be approached directly, but only immanently, via a Re-Entry and, as such, as being either explorative or experimental (or it can disappear via the detour of the imaginary).

Every attempt at establishing ownness as ownness [*Eigene als Eigenes*], and the other as foreign [*Fremde als Fremdes*], is the attempt at placing, at the level of the quasi-transcendental, the distinction itself on the side of ownness [*Eigenen*]—which, because of its paradoxical structure, merely serves to temporalise and renew it. In this sense, Schäfer writes of a "difference between ownness [*Eigenem*] and otherness [*Fremden*] which is not to be closed by itself"—i.e. "despite all efforts, it is not possible to completely give up one's own, one's own patterns of order, which still have the categorisation of something other [*fremd*] available; and it is equally impossible to let that other [*Fremde*] be completely subsumed in the categorical appropriation." (Schäfer 2009, p. 188)

If one strikes the defusing word "completely" (which evokes a misleading spatial idea of areas upon which ownness [*Eigene*] could rule up to a defined boundary, behind which begins otherness [*Fremde*]) from this formulation, then the paradoxicality of this reflexive figure steps clearly (one could say: completely) to the fore. The paradoxicality of the quasi-transcendental level consists in the fact that ownness [*Eigene*] and otherness [*Fremde*] must be comprehensively thought simultaneously, and cannot be synthesised at a higher level. Ownness [*Eigene*] is just as foreign [*fremd*] (and peculiar [*eigen*]) to one as the other [*Fremde*] is known (and foreign [*fremd*]) to one—and that is just thought from the side of ownness [*Eigen*en].

This brings Waldenfels to think otherness [*Fremde*] topologically, to grasp it as a problem which cannot be thought from a higher level, but rather always only from a perspective. Here, the location of otherness [*Fremde*] in experience is, strictly speaking, a non-place, insofar as it does not concern a place which is somewhere else, but rather which is otherness (Waldenfels 1997, p. 26).

Of course, all of this does not first become a problem when a subjective interest, in the sense of a curiosity in the unknown, is assumed. Rather, a problem already exists, simply put, because of the fact that otherness [*Fremde*] and ownness [*Ei-*

[29] Moreover the solutions can so be compared to their complementary antonyms via the reconstruction of the appropriate problems: on the complementary problem of education cf. e.g. Ahrens 2006.

gene] share a world. With that, the claim of otherness [*Fremde*] is not based upon its strangeness [*Fremdheit*], but rather on its communication,[30] [*Mitteilung*] whereby the division [*Teilung*] of the "co-" delimits the constitution of the "co-" of sharing [*Teilung*] and vice versa.

If the claim of otherness consists in the necessity of sharing [*teilen*] a world (a necessity which, if it would be personally grasped, would, of course, already lead to the self having a problem with itself) in its communication, then the problem is temporalised in its paradoxical form in the context of a process of world disclosure (the calculus of indications is the form in which ownness [*Eigene*] and otherness [*Fremde*] must be simultaneously thought simultaneously and consecutively) and, in this world based form, must be subsumed under the economy of *différance*.

Otherness [*Fremde*] can, in the course of the efforts to disclose a shared [*geteilte*] world, and in the paradoxical form of the Re-Entry summarised here, appear in three different ways: in its being known (the distinction is crossed in the direction of otherness [*Fremden*]), in its absence (the distinction is crossed in the direction of ownness [*Eigenen*]), and in its foreclosure (the distinction undergoes an imaginary cancellation).

The explorer directs his/her interest toward the otherness [*Fremde*] that is foreign [*fremd*] to him, and that s/he thus knows as being foreign [*fremd*] to him/her (this constitutes the undisclosedness of the respective regions, and the fact that the other [*Fremde*] is familiar [*Eigen*] to him/her insofar as s/he recognised it as being other [*Fremdes*]). The experimenter's interest in otherness [*Fremden*] cannot, however, be located by him/her because the otherness [*Fremde*] with which s/he is concerned, is absent—s/he cannot recognise anything foreign [*fremd*] in the area in which s/he directs his/her interest (that constitutes its disclosedness).

Whoever explores a fully disclosed region necessarily becomes a tourist—an explorer actor. Neither is anything foreign [*fremd*] to the tourist, but, in contrast to the experimenter, s/he does not make it his/her problem, but rather sets him/herself above it, in that s/he goes on exploring as if that were still possible. Contrary to what is in most cases the norm, because it here concerns a comparison of the efforts of world disclosure, this means that the explorer, the experimenter, and the tourist are assumed to have an interest in otherness [*Fremden*]. The analysis of the problem is then connected to this assumption and not to something else, such as e.g. lack of interest, inattention, prejudice, etc. (which only depicts an epistemically motivated restriction of the perspective and should not be understood as an empirical judgement about the manner of dealing with otherness).

Generally speaking, in the method of observation chosen here, the tourist stands as a paradigm for the "world disclosure strategy" (which is no longer one), in which the paradox that the world is simultaneously disclosed and undisclosed becomes "dissolved" in the imaginary. This is not an analytical category, but rather an empirical one. The imaginary is, just as in mathematics, always a possible solution for

[30] A corresponding double meaning is also found in the *entitlement* of the unknown in Waldenfels: here it is simultaneously the being-addressed by the unknown and the entitlement of the unknown to be treated justly as the unknown [*Fremden*].

a paradox.[31] The tourist's interest is neither directed toward the recognized other [*Fremde*], nor the absent other [*Fremde*], but rather toward the staging of foreignness [*Fremdheit*], in which the lead role of the explorer is played by the tourist him/herself.

The imaginary of this strategy is easily recognised in the annoyance of the tourist in search of "particularly the less discovered [*erschlossenen*] regions" (TUI catalogue 2008) that s/he feels when reminded of being a tourist by other tourists. For, the pleasure of a journey in a particularly undiscovered [*unerschlossene*] region which, however, has been completely disclosed, presumes the imagining of undisclosedness.

This, of course, is all too easily disturbed by inappropriate experiences, and especially by other tourists recognisable as tourists, who mirror one's own being a tourist. Maintaining this imaginary scene costs a certain amount of effort, whether that be through one's own performance, in which one dresses up as an explorer (the Globetrotter catalogue 2008 carries the motto "live your dreams"), or whether it be through the participation in someone else's production.[32]

In this form, the problem of otherness [*Fremden*] is discarded (as a rule, in the culturalised form of the personal other), rendered exotic, and can only be broken from outside the imagination, just like a screen being torn to the ground.[33] However, the scientist can (or better: should) as little follow the way of the imagination as anyone who is interested in the disclosure of a shared [*geteilte*] world. What is true of everyone who is not so much driven by the need to discover the world, but rather by the notion that the world is not the way it is presented to one, and understands this as a problem, is that they relate to it as shared [*geteilte*] and, at same time, know that they cannot do it justice as such.

That exploration, in its classical form of travelling, degenerates into tourism in an already almost completely disclosed world, and that the tourist, in his/her search for the "less discovered regions" twists and turns, and finally exhausts him/herself in his/her futile efforts (see above, Sect. 2.11), are indications of the empirical changes that the universality of exploration brought with it towards its end.

It is almost certainly very roughly sketched, but nonetheless not wrong, when one claims that, through strengthened trading relations, improved transport infrastructure, accelerated movement in space, and the emergence of long distance travel, on the one hand, and the effects of a mostly technologically enabled increasing interconnectedness of the world, due to global standardisation, norms, mutual influences etc., on the other hand, two opposing trends have been reinforced: firstly, one experiences the problem of the other increasingly in the form of one's own problem

[31] Cf. Lau 2005, p. 92 ff. and Spencer-Brown 1969, p. xxi.

[32] TUI advertises its adventure offers so: "World explorer" with "insiders" who "open doors that stay closed to others"; on top of this they say: "Wake your pioneering spirit"; "with our world experience we lead you to world explorer goals […] individually put your journey together. Or choose a perfectly organised TUI packet."

[33] Which is why the tourist regularly finds it "sobering" at the foreign police station, while s/he would never describe the situation in a police station at home as "sobering", but rather as annoying or embarrassing.

(which is preferably discussed under the aspect of the increase in contingency).[34] Today, one can formulate this as knowledge: "Foreignness [*Fremdheit*] is self referential" (Waldenfels 2006, p. 8). Secondly, the search for otherness [*Fremden*] in an increasingly disclosed world ends, more often than not, in nothing.

After all, if one nearly always everywhere only meets with the known, then the concept of exploration as a universal knowledge acquisition strategy becomes shaky. While the problem of otherness [*Fremden*] in the "age of exploration" presented itself to the explorer as matching his/her interests in disclosure, insofar as it was directed toward a recognised otherness [*Fremde*], it represented an existential problem, threatening what is one's own [*Eigene*] for those deemed other [*Fremden*] from the perspective of the explorer, namely as a concrete intrusion of otherness [*Fremden*] in one's own space.[35]

With the increasing disclosure of the world, this problem of otherness [*Fremden*] has returned to the traveller, and became recognised as a problem of his/her own categories which, in the encounter with otherness [*Fremden*], were revealed as being contingent, without one being able to simply distance oneself from them.[36] If one takes this problem seriously, then one must make disclosedness and the absence of otherness [*Fremden*] the starting point of thought, and that means: experimentation.

If one considers this dimension of world disclosure then one can postulate the position of otherness [*Fremde*] in exploration and in the experiment in the following formula: the paradigmatic problem of exploration is the problem of otherness [*Fremden*]. However, the problem of otherness is not the paradigmatic problem of the experiment. It is its absence.[37] In other words: the more otherness becomes a problem in its absence, the more necessary becomes the conversion from exploration to the experiment.

That the quasi-transcendental status of the distinction between ownness [*Eigenen*] and otherness [*Fremden*] remains unseen, and that Re-Entry is not recog-

[34] Waldenfels describes the changes mainly as changes in the structures of reason itself, as an adventure "was accompanied by voyages of discovery and conquest in which new and distant worlds were opened up and 'wonderful riches' were accumulated […]; however, it is first in the eighteenth and nineteenth centuries and then completely in the twentieth century that the foreign [*Fremde*] expressly and irrevocably penetrated the centre of reason and the centre of the what is one's own [*Eigenen*]." (Waldenfels 1997, p. 16 f.).

[35] Cf. the exemplary and more differentiated: Todorov 1984.

[36] Even the explorer Georg Forster, who, in the context of his time counted as an exemplary model in his attentiveness to the foreigner, only had the categories to hand that were available to him, as an equally attentive contemporary remarked: "Ay, ay, dear Forster", Christoph Martin Wieland rebuked Forster, who was describing the court dealings of a Haitian charged with stealing, instructing him: "where, in this moment, was your philosophy—how can you demand of young people that they should have read your Puffendorf and Barbenac? […] You should not steal! is a positive civil law, which we must be brought up to observe." (Wieland 1825, p. 205 f.) Georg Forster accompanied, amongst others, James Cook on his second world circumnavigation, Alexander von Humboldt on his travels through Europe, and was a member of the Royal Society when he was 23. (Cf. Forster 2007/1777).

[37] That none of the forms of world disclosure can be thought without reference to the foreign [*Fremde*], but that this, at the same time, was traditionally never thought decisively enough, can be read with reference to theories of *Bildung* in Wimmer 1996a and Schäfer 2006.

nised as an empirical necessity, or is even rejected as a "philosophical sophistry", explains the pastoral tone of many texts about otherness [*Fremden*] (namely, in their attempt at working on the quasi-transcendental distinction themselves, something which is not possible, other than theologically[38]), and the penchant for mystifying interpretations of such authors, who attempt to think otherness [*Fremden*] in all its consequences.[39]

The attempt to erect rules for dealing with otherness [*Fremden*], without taking into consideration that the insight into the unavoidability of missing it is something other than the problem of its absence, is equivalent to the attempt to develop an epistemology from the insight into the inaccessibility of the world. For, if one only meets the known in the search for otherness [*Fremden*], then it does not help to know that otherness [*Fremde*] is never completely subsumed by ownness [*Eigenen*], just as it does not help the scientist being constantly instructed by the philosopher that nothing in the world can ever be totally and completely disclosed (and especially not the world as a whole) while he is fighting with the problem of no longer being able to simply step into a boat in order to discover something new.

The texts about otherness [*Fremden*] which are filled with warnings to acknowledge otherness [*Fremde*] and, above all, the (personal) other [*Fremden*] in its foreignness [*Fremdheit*], not to endanger it on travels through one's visits, which therefore assume the knowledge about the foreignness [*Fremdheit*] of otherness [*Fremden*], are by all means not saying something wrong, but their thought remains arrested in exploration. They attempt to solve problems that are already no longer those of exploration, using the perfectionism and reinforcement of explorative strategies.

One recognises such attempts at reinforcement in the demand to look more closely (regarding the primacy of the look in explorative thought systems cf. Sect. 3.5), not to close one's eyes to otherness [*Fremden*], not to try to understand it at the price of its foreignness [*Fremdheit*], to leave well trodden paths, to take distance to the known (cf. Sect. 3.10) or to discover otherness [*Fremde*] "behind" the constructions of the media (cf. Sect. 3.4).

This is all nothing new, but rather a reformulation of what others have already pointed out. If the experimental represents an answer to the demand of an absent otherness [*Fremden*] for its communication, and it is about opening up the possibilities of it communicating in a shared [*geteilten*] world, beginning with the problem of its absence,[40] then those without an awareness for the paradox, who insist upon its foreignness [*Fremdheit*], as if one could make a direct reference to the quasi-

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[38] Cf. Schäfer 2006.

[39] Here I see the motivation for Wimmer's defence of Levinas against interpretations which over theologise. Cf. Wimmer 1988, p. 67 f.

[40] In this sense Latour speaks, with reference to Whitehead, of propositions: "I do not use this term in the epistemological sense of a sentence that is judged to be true or false […], but in the ontological sense of what an actor offers to other actors. The claim is that the price of gaining analytical clarity—words severed from world and then reconnected by reference and judgement—is greater and produces, in the end, more obscurity than granting entities the capacity to connect to one another through events" (1999, p. 309). So it is certain nutrient solutions invented by Pasteur in

transcendental distinction between ownness [*Eigenen*] and otherness [*Fremden*], would necessarily reduce the problem to such an extent as if it only concerned the realisation that otherness [*Fremde*] is undisclosable.

This would thus be undertaken as if the distinction between ownness [*Eigenen*] and otherness [*Fremden*] is congruent with that between the disclosed and the undisclosed, and as if both distinctions could be found in the world. And, so the plea for the recognition of the foreignness [*Fremdheit*] of otherness [*Fremden*] is restricted to the other [*Fremde*] that is recognised as being foreign [*fremd*], whereby the efforts to do justice to its foreignness [*Fremdheit*] threaten to cover up, above all, what the demand of otherness actually was: namely, the demand for communication.

However, otherness [*Fremde*] is nothing that can be located within otherness [*Fremde*], where one could keep it, but rather something whose co-mmunication as a co-mmunicator irrefutably concerns something—whether one likes it or not. And, because it concerns the division [*Teilung*] of a shared [*geteilte*] world, the experimenter's efforts at disclosure are directed not toward the divisor [*Teilende*], where one must put a stop to it, but rather toward the shared [*Geteilte*], which, with respect to the creation of communicative possibilities, is a task that cannot be undertaken beyond the world.

3.4 Transparency and Opacity

If, in an experiment, the disclosedness of the world is increased, up until the boundaries of its completion by the closure of a space in the world, in order to attempt to open an absent otherness [*Fremden*] the possibility to communicate, through the strategic exploitation of the iterability of their material-semiotic constitution,[41] then, one can no longer meaningfully speak of an "in between" with regards to the mediums involved in the event. How should one place a medium between something missing and everything else which is nothing other than the medium itself? Perhaps, in this respect, one can understand the criticism that the concept of medium has

which, in his example, the lactic acid ferment can "articulate" itself, so that Pasteur can then form a "collective" with the nutrient solutions and ferment together.

[41] These figures of thought are drawn from—even if they are not at first recognisable in this conceptual form—Koller's (*Bildungs-*) theoretical discussion of Lyotard (1999). The phrase, that that which the processes of *Bildung* are concerned with is opening an absent unknown [*Fremden*], i.e. *something* the possibility to communicate, is the suggestion for a translation of the idea of *Bildung* as a linguistically innovative process of the invention [*(Er-)Findens*] of new kinds of discourse in the conceptuality of this work. As an idea, which has been transferred from one theoretical context to another, and has been replaced by something else, its origins are easily lost sight of—but not because it has been rejected and also not because it has been adopted, but rather because it is presupposed to be mobilisable in its transferred and displaced form rather than in its disclosedness (cf. here Sects. 3.8 and 3.17).

been subjected to in a successively radicalising manner[42] as a semantic correlative to the empirical exhaustion of explorative strategies.

One also finds the remains of a classical—i.e. starting from the universality of the explorative—understanding of medium in the neglect of technology as a no less irreducible [*unhintergehbares*] medium of insight as language. Werner Kogge sees a clear parallel when he describes the changes in the philosophical dispute with technology as analogous to those with language (Kogge 2001). In both cases, the middle, the medium, has shifted to a primary position. For him, the philosophy of language is no longer simply a branch of philosophy; philosophy has become the philosophy of language.

However, Kogge holds that technology has been sidelined in the discovery of this irreducibility, and language's more than secondary role: "the dominance of the philosophy of language", according to Kogge, "pushed that into the background which counts for language and, in a certain sense, counts even more so for technology: how we experience the world does not solely depend upon in which language we do so, but also with which tools and instruments we are thereby equipped with." (Kogge 2001, p. 277)

For Kogge, insofar as the philosophical occupation with technology as a mediator stretches back to the beginnings of philosophy, one can even understand the philosophy of technology in a certain way as the precursor to the philosophy of language. This, however, cannot be in an explicit sense, for there has never been a continued tradition of the philosophy of technology. (Or, if one follows the accepted canon, it first appears with Ernst Kapp's *Grundlinien einer Philosophie der Technik: Zur Entstehungsgeschichte der Kultur aus neuen Gesichtspunkten* from 1978 [orig. 1877] (Principles of a philosophy of technology: the emergence of culture from a new perspective)).

However, it is probably not so much the absence of a "philosophy of technology" having a rich tradition, which technology could have used, as Krogge would have it, in order to be taken seriously as a mediator of knowledge. Such a perception would have perhaps even made it more difficult, just as the enclosure of language problems in a "philosophy of language" has rendered insights into all the relevant questions of philosophy more difficult, rather than aiding them (an unmistakeable sign of the explorative approach: beginning with the isolation of an object of research: cf. Sect. 3.20).

The problem of perceiving technology as a mediator of knowledge consists in it only being identifiable as technology and as a medium when it is already no longer a mediator of knowledge. For, experimental technology, which serves as a mediator for knowledge, does not, in its transparency, stand between the things and an observer, as does the telescope become tool in the explorative process, when it is the epistemic process itself which constitutes the distinction between medium and object of "observation" (cf. Sect. 3.5), and so also determines the status of the "ob-

[42] Cf. Wimmer 2009 for a problem centred overview of the decisive, sometimes repeated here, and sometimes presumed to be known, aspects of this critique from the perspective of the educational scientist.

server" (see below), who can no longer be meaningfully designated as an observer (cf. also Sect. 4.6).

In order to be able to think the technology involved in an experiment as an observational medium, according to the model of the telescope, the epistemic objects (cf. Sect. 3.6) must be imagined as existing independently. It is, however, precisely this that is only possible *ex post*, when that which is at stake is *absent*. And, even if the epistemic objects have, at the end of an experimental process, been converted from the vagueness of a collection of unclear and unassignable traces to a repeatable stability, they are never present as such, but rather only appear in the texture of the technology of the laboratory, the experimental system itself. No-one has ever seen the product of a radioactive process of decay face to face, beyond the supporting technological structures. How can it be possible *not* to understand such a particle with Derrida in connection with an experimental system, when he writes:

> To think the unique within the system, to inscribe it there, such is the gesture of the arche-writing: arche-violence, loss of the proper, of absolute proximity, of self-presence, in truth the loss of what has never taken place, of a self-presence which has never been given but only dreamed of and always already split, repeated, incapable of appearing to itself except in its own disappearance. (Derrida 1997/1967, p. 112)

The technological arrangement of an experimental system that is in the position of demonstrating something true is thus the result, and not the means, of an experimental process: "the experimental creation of traces is finally to be equivocated with the emphasis of epistemic objects. Stabilised recursively these can act as the embodiment of concepts" (Rheinberger 2000, p. 240). The technological arrangement has found an ideal form and is, as technology, only technological. It has become possible to repeatedly reproduce the same results again and again.

In the idea of the experiment as a medium for exploration this counts as proof of the existence of the object, and the existence of a corresponding relation between theory and the empirical. However, in the idea of the experiment as an irreducible [*unhintergehbarem*] medium, the repetition indicates nothing other than the repetition in its produced ideality itself:

> But this ideality, which is but another name for the permanence of the same and the possibility of its repetition, does not exist in the world, and it does not come from another world; it depends entirely on the possibility of acts of repetition. Its 'being' is proportionate to the power of repetition; absolute ideality is the correlate of a possibility of indefinite repetition. (Derrida 1973, p. 52)

One now sees more precisely why the artificiality and seclusion of the experimental system from the world, the whole complex arrangement, is necessarily bound up with the existence of the scientific object. It exists only because this ideal location of repetition exists—not because of the existence of the locations where they are, at some time, discovered and described. It is because of this that Shapin and Schaffer could understand the distribution of the vacuum on the basis of the distribution of the air pump in Europe.

Only after science becomes a global functional system (cf. Luhmann 1992a) does the potential of the reproduction of the vacuum pump collapse with the exis-

tence of air pressure in this world. When one understands meaning as the unity of actuality and potentiality, in the "age of experimental science", then this includes the possibility, or impossibility, of building a functioning air pump.

However, even after the delimitation of a global functional system of science divides [*teilt*] the world that it researches, in that it brings to existence an ideality in a space separated from the world, which could not exist externally, and yet is nothing other than a part [*Teil*] of this shared [*geteilten*] world. It is entirely in this sense that Derrida further writes—and again it reads as if he was trying to create an exact description of an experimental system as an enhanced form of the disclosedness of the world in the world: "But this ideality, which is but another name for the permanence of the same and the possibility of its repetition, does not exist in the world, and it does not come from another world; it depends entirely on the possibility of repetition, as it is constituted through this" (Derrida 1973, p. 52)

The problem of saying something about technology as a mediator of knowledge lies firstly in the difficulty of being able to identify it as technology, and as a medium. It is not straightforward because the simple distinction between "dry, manufactured and mechanical" on the part of technology, and "moist and natural" on the part of life, no longer functions since the living, such as fruit flies, can be employed as technology, and, vice versa, a technological function can be the goal of epistemological efforts, or the boundary between technology and life, or technology and epistemic objects can run right through a living creature.

In fact, it is even impossible to determine the essence of technology in an experimental system. For, it is not the circumstance that decides what counts as technology: "Technology does not decide what counts as technology and what not, but rather the epistemological process" (Rheinberger 2005, p. 24). This indecisiveness about whether it is an epistemic object or a medium is not a problem brought in externally by one who attempts to describe the experiment, but rather one that the experiment itself causes, bringing itself in difficulty. Rheinberger follows this in his description of the beginnings of the protein synthesis in a test tube in the way that the experimenters linguistically orient themselves in this space of vagueness:

> Soon, the language in which the experimental representation of protein synthesis was captured began to reflect the intricate packing of technical conditions and scientific object as well as the practical power of this package. The laboratory community began to speak about amino acid incorporation, no longer in terms of tissue-specific rates of 'uptake,' but in terms of centrifugal velocities, sedimentation properties, and precipitation conditions. There were 'pH 5 precipitates', '40,000 × g pellets' and 'soluble fractions'. (Rheinberger 1997, p. 71, cf. also Latour 1987, p. 87 f. and here Sect. 3.6)

Thus, in a certain manner, they simultaneously and indecisively dealt with the medium of the high speed centrifuge, and with that which it possibly mediated. Just as technology can only be determined as a knowledge medium *ex post*, correspondingly, epistemic objects can also only be identified as such *ex post*. The concept "epistemic objects" is thereby misleading insofar as it firstly does not necessarily concern a thing ("They are material entities or processes—physical structures, chemical reactions, biological functions—that constitute the objects of inquiry", Rheinberger 1997, p. 28) and secondly, is nothing that, as such, can be designated

as something. It is something which draws the interest of the experimenter, so that, even when, at the same time, it is not "something", it is also not nothing,—presuming, of course, it will have been something.

The need to define what technology is may not be given into in the experiment (not even in the experimental efforts to obtain insight into the experiment: to give into the need to provide a definition of technology here at the beginning would already be a commitment to an explorative approach). The problems of scientific theory, and that which would be later staged as the dispute between "realists" and "constructivists", are all based upon the attempt to view technology as something *in itself*, separate from the epistemic objects—i.e. recursively rendering absolute the ex-post-condition of the division between medium and thing, and making the result the starting point of its thought. This is a mistake that the thought of technology, from the very beginning on, prevents. It is, however, in all innocence, to be found at the beginning of nearly every treatise on technology in which the most exact definition of technology possible is either put forward or demanded.

If medium lose their status as something secondary, and their irreducibility becomes *a priori* recognisable from world and self relations (cf. Wimmer 2009), then insight, and the acquisition of knowledge, can, of course, no longer be thought of as the import of external truths into an inner context of meaning, as a mirrored representation of an externality in an interiority.[43] There is nothing in the world (cf. Sect. 2.8) which is not there as disclosed and therefore mediated—for it is precisely that which constitutes the boundaries of the world: that there is nothing beyond a medium to which we would have access.

The idea that the world out there is represented in language (in science, in theory) is seamlessly included in the explorative idea of the research of an open, unlocked space. One goes out into the world, discovers and describes. However, as soon as the world closes, and all that lies before has already been disclosed, then science, insofar as it simply goes on exploring, runs the danger of running around itself in circles like a tourist, and thereby exhausting itself.

The fact that science does not suffer from this fate is not entirely due to it largely distancing itself from exploration. Its constitution as a functional system enables it to escape this danger without having to produce knowledge. Analogous to the existing distinction between the disclosed and the undisclosed in exploration, it can call upon the existing distinction between science and non-science. Included in this is the declaration that everything that is admittedly *actually* already disclosed, but is not yet available in its citable form, is *scientifically* undisclosed. It therefore relies upon the insight free task of the labelling of that already known as "scientific" (the corresponding figure in the legal system is the notary).

With this (and not just with this), the scientific project distances itself from the project of *Bildung*, or produces from within a challenge to *Bildung* for all those participating in the business of science. This consists of orienting oneself in opposition

[43] For an account of the mirror metaphor for representation cf. e.g. Rorty 1979, and for the *Bildung's* theoretical discussion cf. Wimmer 1999.

to the operation of the business of knowledge, and proofing the work done on the distinction between disclosedness and undisclosedness against one's own thought.

In view of the corresponding orientation of the economy of science, brought about by the techniques of proficiency testing, the emphasis on the explorative forming "notary business" (one sees, one describes what one finds in the not yet citable existing world) simply becomes prominent—an alternative to the production of insights which threatens to wholly dissolve science, especially when a decisive, objective-technological, exteriorised tradition of the experimental is absent. Such sciences are likely to be swamped by the persistence of an explorative understanding of science.

The persistence of the explorative thought system (cf. Sect. 3.5) is especially demonstrated with reference to the understanding of the medium, in the attempt to understand even the experiment exploratively. This is not that easy, as one must succeed in playing down the work in the laboratory, and on the apparatus which, even an outsider knows, costs much time and attention, to such an extent that its function presents itself merely as secondary, irrelevant for the consideration of the processes of insight. For, in that moment that one assigns a value for insight to this work, all the supports for explorative thought break down (primarily those of the eye and of space), and can no longer be claimed as normative (demands for distancing, prohibition of the invention and the laugh), whereby the associated hopes are torn down (hope for an ahistorical validity, of unity and endless repetition), and finally threatens the person of the scientist, including the scientific theoretician (his/her central position, his/her sovereignty, his/her legitimacy to represent).

What it means—with reference to the technology used in the laboratory –remaining trapped in a negative manner within the dominant ideas of a neutral, transparent knowledge medium and so within an explorative approach, becomes clear from a misunderstanding.[44] Benner writes:

> Whoever, for example, believes to recognise the organisational structure of material in those atoms about which such a fuss was made in the Brussels' 1958 world fair, and can still be seen today, and does not know that this exhibition model concerns an atomic theoretical model constructed by physicists has, as more and more physicists today complain, understood nothing about theoretical physics. (Benner 1995, p. 292)

Naturally Benner does not assume that the physicists have here constructed a model for laymen while they themselves work with a more exact model of reality, and that is why the layman understands nothing of physics if s/he holds this to be an appropriate model. He also does not want to say that the Atomium cannot be an appropriate model because it can hardly depict the multi-dimensional mathematics of modern physics with its three dimensional form.

He rather wishes to make clear that the objects of contemporary science no longer let themselves be shown, as did their earlier counterparts. From this, he concludes that "it concerns a construction", and not because it is a construction, because the Atomium obviously *is* not an atom, but rather because it *represents* a constructed model. He concludes that the medial function no longer counts because, as one can

[44] With reference to this example also cf. Ahrens 2009.

see with the false model of the Atomium, the objects of modern physics have finally managed to evade the area of influence of even the media dominated gaze, and are therefore no longer that about which one can assume an everyday knowledge of.

Thus, there remains only the other side of technology (which is, for him, now no longer a medium because it no longer mediates anything but, at the same time, however, is still thought of, in a certain way, as a medium, because it allows him to defeat it on one of both its sides). Benner writes that the postulative systems of contemporary science "[are] not the result of an inductive ascent from the experience of one to the whole, *but rather the construction of a hypothetical legislation, originating in our understanding*, which explains the manifold of the given and renders it accessible" (Benner 1995, p. 399, my emphasis).

One could describe this as a post-medial understanding of science. For, if the construction actually does stem from our, or the theoretician's, understanding, then the technology in the laboratory no longer stands *between* that into which insight is to be gained and the scientist. Here, Benner stands wholly within Popper's tradition, who also believed that one could think laboratory science from the perspective of the theoretician, and did not at all need to attempt to think of laboratory technology and experimental systems in themselves.[45]

Here, technology is merely applied after the process of knowledge acquisition as a control instance, and simply differentiates insight from error. The driving force behind the scientific-theoretical discussion in the tradition of the Vienna circle up until Kuhn, and including Feyerabend (see Sect. 4.7), which finally leads to the aporias and trivialities of social constructivism, is the paradoxical handling of the knowledge medium of technology. This paradox remains unseen only because the contradiction, raised to a paradox, which remains in a certain way in the shadows of the current discussions, exists between two mutually exclusive certainties, both of which deliver reasons for not thinking technology as a medium.

It does not need to be thought because no medium is able to permit the understanding of something which would thereby become insight—that would be pre-Kantian. Therefore, nothing new can be solely demonstrated in the laboratory (everything that is new must originate in theory).

One needs the laboratory only for the falsification of hypotheses—the technology itself does not thereby need to be thought about, because it directly demonstrates whether a hypothesis is useful or not (it is not a question of insight, but rather of a technical implementation to aid the theoretician in making sure that something is falsifiable). Although direct access to the truth cannot exist, there is direct access to error: this is, although negative, so pure that one does not need to expend a thought on the medium. Either a hypothesis fails or it remains standing.

This is what is meant when one talks of the explorative thought system having its back against the wall with theories of falsification. Technology functions here in an unseen manner. Popper implicitly formulates a technological imperative—his

[45] For François Jullien such a figure shows a variation of Platonism: "We set up an ideal form (eidos), which we take to be a goal (telos), and we then act in such a way as to make it become fact (2004, p. 1).

demand that all knowledge must be falsifiable can be translated as: write down only those thoughts the falsifiablity of which lie within the area of that which is technologically feasible (his hate of psychoanalysis is based on this, and not on a purely epistemological level[46]).

The logic of research is therefore in reality a disguised logic of technology.[47] And the model of falsification is also, in this respect, the last serious attempt at saving the universality of the explorative system of thought,[48] before a trivial constructivism lent its name to the inability of thought without a system, which is in the precarious transitional phase to experimental thought.

Only so, on the basis of the idea that technology could be simultaneously thought of as not a medium, and as a pure medium, was it possible to understand the experiment as a means of falsification or, earlier, of verification of theory, and not as a generator of new questions and insights.

Scientific theory thus remained locked within the explorative idea, one must be able to point to things with one's finger—and, if one cannot, then one must ask how: does one deal with *that*? Put otherwise: first, one did not need to think about technology because, as a pure medium, it made itself disappear. Then, one no longer needed to think about technology because it no longer mediated anything—it merely constructed something. The insight that media not only allow a view of something, but rather also distort or falsify, belongs decisively to the medial, visually centred understanding of science, and its negative counterpart, the post-medial.

The question is, in fact, whether that which one can see corresponds to the truth, or is rather falsified, construed or constructed, a question which only makes sense in an explorative system of thought. What sense should such a question have in an experiment where that which is to be falsified, construed or constructed is simply *absent*?

This consideration of the falsification and defects of the medial function of technology is utterly compatible with a purely explorative approach and must be clearly differentiated from thinking technology in the experiment. In Kepler's best telescope the stars appeared as multi-coloured squares, not exactly what one imagines from a pure medium. On top of this, Kepler suffered from a sight defect as well, which made him see objects, doubled or trebled according to their distance. And, because the objects with which he dealt were already far away, he sometimes saw, according to his own information "instead of a single moon, ten or more present themselves to me" (Feyerabend 1975, p. 88).

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[46] Stengers sees Popper motivated by two equally pressing wishes: the wish to stylise Einstein as a scientific model and the wish to reject psychoanalysis's claim to being a science. See Stengers 2000, esp. p. 27 f.

[47] In this sense Luhmann turns the grounding figure on its head: "Said otherwise, technology concerns the testing of plays of possible combinations for combinational gains. That it works, when it works, is also here the only clue that reality tolerates such a thing. In other words, we reverse the usual assumption: it is not technology which becomes isomorphically constructed according to nature, but rather nature that isomorphs in the respectively relevant combinatory space according to what one can technologically attempt." (Luhmann 1992b, p. 263).

[48] To be precise one could also call Lakato's attempt the saving of falsificationism.

So, when it comes down to knowledge, and one does not progress within a disclosed world with the explorative idea of a representation of an outer, undisclosed world, then one must refer to an already disclosed world as disclosed, and not as a non—(scientifically)—disclosed one. And, together with the idea of a medium as something transparent between oneself and the world, the primacy of the eye, the idea of the visual, as the gateway for insight, collapses.

3.5 Observation and Processing

> "Not having to 'think with one's fingers' is equivalent to lacking a part of one's normally, phylogenetically human mind"
>
> —André Leroi-Gourhan 1993/1964, p. 255

In the eyes of those who always first think of telescopes, microscopes and cameras with respect to technological knowledge media, the way to insight presents itself as a constant extending of the field of vision, as an explorative approach. However, behind their backs, the experimental approach begins in the hands of the experimenter taking each step towards insight with the limitation of the somewhat arbitrary choice of a slice of reality, understood up until the limits of its totality.

> The observing gaze refrains from intervening: it is silent and gestureless. Observation leaves things as they are; there is nothing hidden to it in what is given. The correlative of observation is never the invisible, but always the immediately visible, once one has removed the obstacles erected to reason by theories and to the senses by the imagination. (Foucault 1976, p. 107)

A shift of meaning took place in the transition from explorative to experimental science, from the eye to the hand, and thus a shift from observation to processing.[49] Exploring is primarily an affair of the eye, using transparent media as means of extending the field of vision. The telescope brings sight to distant, alien regions, the microscope lets tiny, alien particles be seen, and the ship (later, the space ship) brings one to a place "where no man has gone before"—an expression which, like no other, still stands for the explorative influenced idea of the scientifically motivated striving for the new.[50] Experiments, on the other hand, live from fiddling with apparatus, through which the hand is revalued in comparison with the eye.

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[49] While philosophy cannot simply observe this development from an external point of view, nevertheless, the "starting point of philosophy […] that perceives with the naked eye", as some ascertain (Berr 1994, p. 205) and its development cannot itself be excluded from technology shifts—e.g. the changeover of recording systems (cf. e.g. Kittler 1985).

[50] That an explorative understanding of science is dominant is one thing. The other is that explorative science in the media is also over represented for media reasons. As visually centred science it is immeasurably better to stage in the visually centred media such as cinema or the television than the experimental. Put otherwise: watching how someone repeats the same experiment a hundred times is simply not as exciting as accompanying someone on a voyage. That the representative world is really predominantly populated by scientist clichés has been shown by e.g. Rahm and Charbonneau 1997.

However, it is only a part of technology that becomes an object of these fiddling changes, quite simply because scientists have to use technology that they do not fully understand or, to remain linguistically coherent, are opaque to them, remaining a "black box" and they therefore leave it untouched.[51] This is a usage of technology in which *it makes no difference* whether one understands it or not,[52] whether or not it is a black box, for the user is therefore using technology as a tool (see Sect. 3.17).[53]

In the explorative system of thought there are only tools. The straightforward technology critique now just repeats, again and again, that technology is not sufficiently understood as a tool. That is correct, but only helps to a certain extent. For, in the well meaning, but thereby simply repeated, emphasis that technology cannot simply be understood as a means to an end, this simple technology critique runs the danger of making one forget that technology in use is often just that, or, at least, is used as such: a mere tool, a plain means to an end, in which it is utterly inconsequential whether one knows how it works or not.

The challenge for exploratory research consists of describing an object as precisely as possible, without thereby changing it in the process of observation. Contrary to what is sometimes claimed today, it is naturally not so that every observation is associated with an intervention in the environment of the respective research object, which leads to errors in observation. Such claims, which are obviously made without any sense of proportion, are perhaps interpretable as symptoms of a crisis of the universality of the explorative system of thought coming to an end, in which

[51] The use of technology as a black box is equally constitutive for science classically characterised "experimental" as for that classically understood as "purely theoretical." For an account of this cf. Latour 1987, p. 3 and regarding the equally systematic as interdisciplinary meaning of the black box cf. Stengers' essay *Black Boxes; or, Is Psychoanalysis a Science?* In: 1997, pp. 79–108.

[52] There are authors such as Ropohl (1991) who draw up their discussions between Bildung and technology according to whether technology has been understood or not. Even if the argumentation is woven somewhat more shrewdly it is not entirely wrong to say that for Ropohl it is educationally more valuable when it is understood how technology works than not. He correspondingly tries to solve the problem that not everyone can understand everything using a compromise, but without deviating from the aim of obtaining a sovereign command of knowledge: "Orientation patterns and overview perspectives which in the first instance at all allow the sovereign handling of the knowledge resources made available by information technologies", must be paired with thematically focussed, expert knowledge. Only in that Ropohl constructs two impossible marginal figures within this set theory kind of understanding of science, the "nerd", who knows everything from only a little" and the "dilettante" who "knows only a little about everything" (Ropohl 1991, p. 236), is he able with the aid of healthy common sense then propagate the middle way as *Bildung*: "the alternative that I favour consists of grasping the individually selected regions of reality within several important perspectives, and then learning to connect these perspectives, without neglecting certain points of focus." (Ibid.).

[53] And if this approach is directed toward humans themselves then it is itself "technical" in the sense of a tool: "We understand ourselves from much that we do not understand", Meyer-Drawe writes, and adds: "We understand us so from ourselves, but do not understand us. The uncritical acceptance of the loss of reference [the acceptance of the image of the autopoetical machine as an image of humankind] attests to this fundamental technical character and our indifference to the machinery." (Meyer-Drawe 1995, p. 370).

those observations having no influence on the object of research, at best situated in its natural environment, were considered ideal.[54]

As long as there was no opposing concept of the experimental to the explorative, and exploration and experimentation could not be understood as the Re-Entry of an unprocessable distinction, and the possibility of assigning the various knowledge acquisition strategical moves to the one or other side of the distinction was not available, then the critique regarding the universality of the explorative must itself take on universal dimensions.

In this case, too, the experimental establishes itself where the explorative has arrived at the limits of its possibilities, namely the inability to observe certain objects neutrally and from a distance in their natural environment. It [the experimental] emphasises this problem, instead of avoiding it. (Just as it increases the disclosure which brought exploration to the limits of its possibilities; just as it resists the increasing decline of the open enclosure in order to counteract the number of possibilities in the open space of the "experience of the impossible" and renders them as conditions of the eventfulness of the event (Derrida 2007, p. 451); just as it meets the problem of an increasing lack of otherness [*Fremdem*], not with a more deep reaching search, but with the contouring of its absence).

So, instead of here intensifying the efforts at minimising the influence of observation, and at not changing the natural environment, the experimenter takes to heart the things with which s/he deals with,[55] works upon them to such an extent that hardly anyone is able to recognise them, and relocates them in the most artificial environment one could at all find in the world: the laboratory.

One can describe this as a transition from observation to processing. To be precise, it must be stated: the primacy of observation shifted to processing. For, of course, explorative things must be processed and experimental things must be observed. And, if one observes experimental work from the vantage of the explorative thought system, and thereby does not take the temporal structure of the experiment into consideration (cf. Sect. 3.2), or the relation between epistemological and technological things (cf. the next section), then one could even say: the object of research remains unchanged in the experiment too, one has simply built observatory machinery around it.

The stabilised form of a *factum* enables the recursive identification with the explorer: at the end of an experiment one will have only ever observed one's object of research. The primacy of observation indeed loses its plausibility in a world increasingly changing due to the real effect of processing—even for a critic trapped in an explorative thought system, who, because of his/her continual late arrival, is hardly to be distinguished from a historian.

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[54] And again one recognises in the many (and without an understanding for the unintelligible) references to quantum physics which obviously have the need to save, if not the universality of the explorative then at least its universality in the form of its comprehensive failure.

[55] The literal meaning of "Begreifen", "Begriff", "comprehende" or "to grasp" perhaps already shows in what respect the history of the experimental transcends science.

3.6 Research Objects and Epistemic objects

If that "which counts as technology and that which does not […] [decides] not the technology, but the epistemological process" (see above), and the distinction between technological and epistemic objects in the experiment can no longer at all be essentially made, then that requires that with which an experiment concerns itself, a description with its focus on its transformation into an epistemological process. Rudolf Stichweh, who does not distinguish between different forms of knowledge acquisition (such as explorative and experimental), but rather, as do many of the new generation of researchers of science, tries to provide a *universal* description of science, *on the basis of experimental science*, correspondingly formulated—certainly unintentionally—to the distinction between the explorative and experimental approach, on the basis of the relation between research processes and objects of research:

> In a classical epistemological idea science has to do with material objects and symbolic models (of these objects). This distinction is levelled out if, on the one hand, the object to be investigated is no longer observed, but processed, so selected, purified and materially transformed that it can no longer represent itself in the research process, but is, at the same time, suited as a model for a general class of objects, and when, on the other hand, the manipulation of these physical models is carried out in place of, or at least beside, the manipulation of symbols. (Stichweh 1994, p. 291)

One could describe what Stichweh designates here as a classical epistemological idea as the representation appropriate for the explorative approach, but not for the experimental approach. The consequences that Stichweh draws from the empirical changes he sketches refer correspondingly explicitly to the experiment:

> The pursuance of questions or problems then takes place in the form of such a manipulation of physical models. One could pointedly also say: the next step imposing itself in the experimental procedure defines or *is* the problem which directly serves to guide research. (Ibid.)

The goal of the experimental approach remains the stabilisation of constants, which, in what follows, can be again assumed as a given. These constants, however, cannot be previously determined as something—and, as opposed to the explorative approach, can no longer be determined as something indeterminate.

Rather, they continually alter their form, are not something determinate, but also, neither are they nothing, for *somehow* they provide the reason for research. In short, that which is of concern is blurred and vague. The meaning of this blurring and vagueness can be found in the many texts of the history of science which do not begin with the results, but in which the knowledge acquisition process itself is followed step by step.

Rheinberger has collected a number of these attempts to describe this uncertainty in the course of the research process: Claude Bernard speaks of vagueness, the unknown that moves the world; Ludwik Fleck speaks of "unclear ideas" in his reconstruction of the history of the Wassermann reaction; Yejuda Elkana speaks of "concepts that are in flow" in the context of the beginnings of thermodynamics; the early history of immunology is described by Ilana Löwy as being influenced by "blurred

concepts" and the construction of "federative experimental strategies"; Abraham Moses generally dedicates himself to the function of the blurred in science; Paul Feyerabend speaks of the necessity of ambiguity; Hans Blumenberg speaks of the epistemology of the "non-conceptual" (Rheinberger 2001, p. 24); and Michel Serres describes in the foreword of the anthology "Elements of a History of Science" this groping movement around a vague, unclear something, of which one as yet knows nothing, and that, nevertheless, makes the whole difference (Serres 1994, p. 35) as a central characteristic of research.

The insight, that one cannot think using unclear concepts, is correct. It is just as correct as the insight that one cannot see very far with an opaque telescope. But it is wholly apt only for the explorative approach, in which the technological medium must be as pure as possible and the conceptual tools must be as sharp as possible. With reference to the experimental approach, in which the clear concept marks the end of the knowledge acquisition process as its result, the clarity of the concept presents itself as a motivating problem, and the art of the experiment consists in concentrating on the all too easily concretising vagueness of concepts in order to maintain them in their vagueness (an idea which must have filled Hobbes with no less horror than the vacuum itself).

Constancy is not the indicator which shows them they are on the right track, but the permanent change, the remaining-in-flow. However, just as experimental work in a completely disclosed space presupposes the previous exploration as the effort at disclosing a space, the focus on the vagueness of epistemic objects presupposes a stable environment. If everything were vague then nothing could show itself.

That the boundaries of the experimental system are determined by technological things does not just mean, and not even unconditionally, that machines are in use, but that their boundaries consist of fixed elements, no matter the material and the form. Technology is the form fixated element, which, in its fixation, can be mobilised. So, just in Rheinberger's consideration of biological experimental research, the following are already counted as technological things:

> Instruments, recording equipment and, especially important for the biological sciences, standardised model organisms together with the complete knowledge base that is, so to say, ossified within them. The technological conditions define not only the horizon and the limits of the experimental system, they are also products of the sedimentation of local or disciplinary working traditions with their measuring apparatus, the access and perhaps also only the preference for specific materials or laboratory animals, the canonised forms of craftsmanship, that is under certain circumstances passed on over decades by experienced laboratory workers. (Rheinberger 2001, p. 25 f.)

Rats, mice, parts of rats, parts of mice, dogs, parts of certain characteristics of dogs could initially have been epistemic objects and now serve as technological things; without the so-called Knockout animal, genetic research (cf. Mitchell 2008, p. 82 f.) is as unthinkable as cancer research without the Onco-mouse (cf. Haraway 1997a, pp. 49–118).

Far from being an instrument for observing an outlying exteriority, the technological conditions limit the possibility of that which can be demonstrated within them and, at the same time, open up their interiority. Latour graphically describes in

an earlier text how the "object" of research, in the form of a list of continually altering collection of properties circulating in the laboratory, in which a phenomenon was categorised as sometimes known, sometimes presumed, by one or the other actor, and that, as such a list, it constantly changed, and sometimes disappeared and sometimes also stabilised—and, as such a stabilised list of properties, first takes on the form of an independent entity (as an epistemological object fixed within the set technological limit conditions). He thus makes clear how the answer to the question as to what technological things and epistemic objects actually will have been, can only be delivered by the epistemological process itself:

> The new object, at the time of its inception, is still undefined. More exactly, it is defined by what it does in the laboratory trials, *nothing more, nothing less* […] The [object] had a shape; this shape was formed by the answers it gave to a series of trials inscribed on the window of an instrument. When the answers changed and could not be ignored a new shape was provided, a new thing emerged, a something, still unnamed, that did exactly the opposite of [the former object]. Observe that in the laboratory, the new object is *named after what it does* […] Inside the laboratory the new object is *a list of written answers to trials*. […] At the time of its emergence, you cannot do better than explain what the new object is by repeating the list of its constitutive actions: 'with A it does this, with C it does that.' It has *no other shape than this list*. The proof is that if you add an item to the list you *redefine the object*, that is, you give it a new shape. (Latour 1987, p. 87 f., emphasis in the original)[56]

(Another example, another experiment: is it possible to stabilise the concept of the experiment successfully enough to lead it out of its vagueness, to the extent that it can be freed from its context, and grafted into the theory of *Bildung*? Is it possible to acquire sufficient contour and stability in this "experimental", which is initially nothing more than a list of properties, having "*no other form than this list*", so that one does not have to redefine the object every time that one adds a property to this list, every time giving it thus a new form? Is it possible to successfully maintain the comprehensibility of the partially violent transformation of concepts which are here being dealt with, their translation from heterogeneous discourses in which one can hardly recognise the connection to their original context?)

It is against this that the success and performance of an experiment is to be gauged: against the extent of the stabilisation, and the distance from the confusion about what it is concerned with, up until the stabilised, the connectable. What it is not to be gauged against: to have described a present object with completed or modified instruments and concepts—that would be the explorative criteria for success.

3.7 Copying and Modifying

If, in an experiment, the disclosure of the world is increased until the limits of its completion through the (de-)partmentalising and closure of a space in the world, in order to open up the possibility of an absent other [*Fremden*] communicating,

[56] A further description of this continual alteration of epistemic objects can also be found in Latour 1999b, ch. 5, and a comparable one in Rheinberger 1997, p. 71; see also here Sect. 3.4.

through the strategical exploitation of the iterability of the material-semiotic constitution of an experimental system, and, as a consequence of this, one can no longer meaningfully speak of the media involved in the event in the sense of an "in-between", then the possibility of the representation of things breaks down, together with the practical non-applicability of the concept of the self presence of those things. The possibility of this representation depends upon the appearance of self presence in the ideality of repetition (therefore, the rejection of alterity within the iteration). Derrida describes the relation of presence, repetition and representation as follows:

> the identity of presence offered to the mastery of repetition was constituted under the 'objective' form of the ideality of the *eidos* or the substantiality of *ousia*. Thereafter, this objectivitiy takes the form of *representation*, of the *idea* as the modification of a self-present substance, conscious and certain of itself at the moment of its relationship to itself. Within its most general form, the mastery of presence acquires a sort of infinite assurance. The power of repetition that the *eidos* and *ousia* made available seems to acquire an absolute independence. Ideality and substantiality relate to themselves, in the element of *res cogitans*, by a movement of pure auto-affection. (Derrida 1997/1967, p. 97 f.)

This is, in the interpretation chosen here, a description of the universal dominance of the explorative system of thought. Just as in every other characterisation of explorative science, it is the symptoms of its crisis with which the reflective sciences have busied themselves in the last decades. There are thus innumerable possibilities of telling the story of the "crisis of representation" [57] and innumerable possibilities of the impossibility of demonstrating knowledge as a (linguistic) representation of an (extra-lingual) exteriority.[58]

Here too, however, it will not be about a variation of an "analytical proof" that *the* representation was never anything other than problematic. Here too, it will again neither concern adding further to the known symptoms of the crisis nor, around this, contributing to the history of representation. Instead of assuming the crisis of representation,[59] it is considered in the context of the increasing disclosure and closure of the world, and serves in the theoretical-pragmatical sense as a contrasting mirror for a more precise determination of the experimental approach and the question as to what replaces representation in the experiment.

From this perspective the crisis appears mainly as an increasing accumulation of situations in which the observer meets him/herself,[60] and the representational model appears as one which harmoniously places itself within the explorative system of

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[57] The literature is not clear; just as an example (and for an overview) cf. Rorty 1979, and, from the perspective of educational science cf. Wimmer 1999.

[58] For an equally randomly chosen example for an overview cf. Gamm 1994 and 2000, esp. p. 183 ff.

[59] Instead, cf. Friedrichs 2008 on the crisis of representation, esp. p. 122 ff.

[60] Naturally, from other perspectives too. It has thus become the custom to begin the story of the crisis of representation with Ethnology (cf. for an overview Berg and Fuchs 1993) as the science which was the first, and most clearly to struggle with the "observation dilemma", i.e. the problem of one's own involvement in the observed event (and naturally not firstly with quantum mechanics). For a problematisation and reflection see esp. Rabinow 1977.

thought. Thus, here, the crisis of representation appears, not as a crisis of representation *per se*, but as a crisis of the *universality* of representation, as a result of, and in the context of, the failure of a complete dominance of scientific rationality by exploration.

One must, therefore, not distance oneself from the idea of representation when thinking of the experiment, because it concerns an idea that is in crisis (the whole system of thought, in which representation occupies only a place is, *in its universality*, in crisis), but rather because the whole order of discrimination—with the theory on the one, one's own, inner side, and the represented things on the other, foreign, exterior side—cannot be sustained when considering the experiment.

The problem of how one brings something from outside into a scientifically internally adequate representation, i.e. describing something as something, is not the experimenter's problem, but rather providing something with the possibility of communicating itself, something that was never outside, but was always already involved in the innermost exclusion of the division [*Teilung*] of the shared [*geteilten*] world, towards which the efforts of disclosure are directed, or, put more precisely: will have been.

Nothing speaks against talking about representation (and problematising this) in the explorative context. And, with the passing of representation as the *only* task of science as a result of the passing of the universality of the explorative, one must not also dismiss the truth, as it was the fashion to claim for some time. If one gives up the image of a mirror-like representation of a prior presence, then, as Wimmer writes, the concept of truth is in no way invalid: "the truth is still there, but its reference has been shifted to the immanence of writing and representation" (1999, p. 56).

When Derrida, for example, writes that there is nothing outside the text, then this is naturally not linguistic fundamentalism in the sense that the hermeneutic is placed as the last ontological background. This idea (and whether it only be in its implicit form or sold as pragmatism) is incompatible with the concept of the world used here. Wimmer adds to this separation from a self sustaining hermeneutic:

> This abyss is thereby itself grasped as an initial problem to be overcome and the process in which the abyss separating the 'things' from the 'words' is first opened is inevitably overseen: the process of the inscription of the world or those mythological moments of signification themselves, in which the network of imaginary ideas and illusions become suspended, which serve as props for daily life, and the world collapses as a contingent exteriority in thought before they (again) take on the delineations of symbolic codification, through which not the things 'in themselves' become separated from language, but a division is introduced in the things themselves, through which they fall into an insoluble dependency upon language as difference, or as 'différance'. Meaning thus loses its ontological foundation and the insinuated identity of language and meaning collapses, together with all the associated ideas of the equivalence of meaning and reality. (Wimmer 1996b, p. 443 f.)

So, if, in experimental science, it is specifically the distinction between "material objects and symbolic models" that has been levelled out, as Stichweh puts it, and it has become necessary, in order to capture events in the knowledge acquisition process, to replace this distinction with the inessential one between epistemological and technological things (cf. Sect. 3.6), a distinction which continually alters in the

course of the research process, but one does not wish to abandon the demand for truth (which is as equally important as the demand to do justice to a shared [*geteilter*] world as shared [*geteilter*]), then the experimental equivalent to the concept of representation caught up in the explorative system of thought is required—and this cannot be the representation itself, introduced *ex post* at the end, after the conclusion of an experiment.

The converse argument, that the experiment becomes necessary as soon as classical representation has arrived at the end of its possibilities, can also be seen in the pedagogical context: Lehmann-Rommels reading of Kant and Dewey intends showing in what respect a form of "experimental thought" can be found in these authors, which "presents an epistemological alternative to the representational understanding of truth according to which knowledge is understood as the correct representation of an independent reality (adequatio rei et intellectus)" (Lehmann-Rommel 2008, p. 122, also cf. here Sect. 3.13).

If, however, one does not understand representation as an isolated or epistemological overarching problem, but, more specifically, as being bound up in the explorative thought system,[61] and asks for its experimental equivalent, then it is not the experiment in general, but *translation* in particular that forms the functional equivalent to representation. Even though translation also presents the experimental equivalent to representation in the explorative approach, their positions are not exchangeable, but rather only understandable in the context of their respective systems of thought.

Just as time in the experiment does not simply occupy the position of space in the explorative thought system (and must there be thought otherwise), discovery cannot simply be replaced by invention (and must there be thought otherwise), and intuition cannot simply take over the function of intention (and must there be thought otherwise: cf. Sect. 3.13), so translation does not simply take over the task of representation, and can therefore not be understood as that which the world mirrors in a representational system (a theory, an experimental system); there is no mirror-like relationship between the two systems of thought.

But, to what extent does the translation in an experiment takeover the task that representation takes on in exploration? The intention of this section is to provide an answer that enables an orientation (not, however, a concluding answer). However, it should firstly be noted, that the crisis of representation is here again not to be imagined as a "merely philosophical" discussion, introduced to science from outside, but a symptom of a very real problem to which the invention of the experiment presents a practical answer: namely, that one cannot inside, from the side of the disclosure of the Re-Entry, grasp an exteriority of the world, in order to represent it inside as an exteriority.

The universal insight postulated by the theoreticians of the crisis of representation, that one cannot easily grasp the exteriority of the world in order to represent it

[61] With that this work takes on a totally different starting point than that of, for example, Friedrichs (2008), who approaches the problem of representation naturally not in isolation, but also not in connection with an explorative thought system.

inside, does not disturb the explorer as s/he anyway directs his/her disclosure efforts towards those areas *in* his/her own world disclosed as being undisclosed, whereby s/he can present his/her discoveries *ex post* as newly disclosed—here, the shifting of the boundaries of the world coincides together with the event of discovery. The experimenter cannot do that: the problem of representation does not present itself as a practically ignorable epistemological problem, for s/he lacks any indication of discovery and, in its undisclosedness, the disclosed destinations in the world.

So, while the explorer works on a pre-given distinction between interior (disclosed) and exterior (undisclosed), the experimenter, before s/he can even begin, must meet *and construct* a distinction between interior (experimental system/disclosed) and exterior (world/likewise disclosed, but in the form of a chaotic, unsurmounted and therefore unworkable disclosedness).

In contrast to the explorer, the question arises as to how one can get something inside from outside, how one should make this distinction and is thus a research practicality in connection with the Re-Entry. S/he must answer it before s/he can even begin the experiment. If the experimental system is only firstly constructed by drawing a boundary to the world, then everything that is subsequently possible depends upon the answer to the question: what belongs to the inside and what to the outside?

Since this concerns, within a disclosed space, working upon the distinction between the disclosed and undisclosed, then the first step cannot consist of fetching the objects concerned, at the very least, because it is precisely that which this concerns, that is lacking. In addition to this, the part of the world which one assumes *as* the "world of epistemic objects" (cf. Sect. 3.6), the world shared [*teilt*] by the epistemic object, and in which it can leave its trace, must be, brought into the laboratory in a practical, concrete and, using all the means available, workable fashion, and freed of all influences having an unclear status as to whether they are either disclosed or undisclosed (information theoretically speaking this concerns noise reduction). This is the world in its *complete* disclosedness, i.e. including everything that is presumed to be relevant to the possibility of communicating the epistemic object (and everything that, in the case of success, will have proved itself to be relevant). The experimenter is, therefore, not concerned with the "segmentation and isolation of a segment of reality", in order to then be able to explore it in exemplary fashion, as Berg (2009) writes.

What appears to be a logical impossibility (and also is, in a classical logical sense), is taken on by the experimenter as a paradoxical, research based practical challenge. If one makes do only with a segment of the world for the purposes of the inspection of a segment of the world, instead of bringing in the world that is *shared* [*geteilte*] with epistemic objects in its totality, then the experiment would no longer be distinguishable from magic. One could create every conceivable result. One could so prove that things fly when one lets them fall—one only needs to carry out the experiment in water, or use things which were lighter than air.

In both cases, one would have been satisfied with both the segment and its exploration. However, it is not about finding out the properties of an epistemic object in the artificial space of a laboratory, but rather, which of its properties exist *at all*,

i.e. are in the world itself. No-one would be interested in the existence of pressure in Boyle's glass globes, if it did not concern the pressure of the air around us, the pressure of the shared [*geteilten*] world.

This was precisely Galileo's problem with those who recognised only those things seen through his telescope as being true, which they already knew to be true without the use of the telescope. It is because of this that the segment of the world must really be there *as* complete—which naturally does not mean charting a map on the scale of 1:1, and declaring the world a laboratory, but is rather the attempt to take into consideration everything that might be in a position to make a difference.[62] The duty of the scientific community correspondingly consists of checking whether everything that might make a difference has been taken into consideration, and the revision of the knowledge base runs accordingly via the co-consideration of factors earlier neglected.

Although the distinction between explorative observation and experimental work is so obvious—in the first case, one can take the environment as a given, and concentrate on the description of the object, while, in the second case, even the answer to the question as to what that which is to be described actually is, depends upon the construction of the environment as world—the question of construction is almost always only introduced to science from outside, as an epistemological question equally relevant *to both forms of research*, instead of taking it seriously, specifically in the context of the experiment as being an equally decisive research practicality, as well as being immanently political.[63]

The question of the construction can, as an epistemological question brought in from outside, be forgotten as a special question for "philosophers on the margins of the playing field", or deported to the feature pages of a magazine. However, if one emphasises the practical necessities of research with which the experimenter constructs a world *as* a world, then the question as to whether the world constructed in the experiment has been constructed as an isolated [*ungeteilte*] world or a shared [*geteilte*] world, and, if it is constructed as a shared world, then who or what can co-mmunicate (itself) here (see also Sect. 3.21), is pushed to the fore.

This is a question which cannot accordingly be opened up and clarified *in the* scientific scholarship of an experiment—it concerns everyone, and refers beyond science to the acquired and physically sedimented sense of all the individuals involved both in and beyond science, as to whether something is lacking, and what that might be.

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[62] The hologram in which each segment contains the whole image could be a fitting metaphor for this.

[63] The epistemological theoretician Tom Tetens explains it so to the interested layman: "every theory concerns itself with a certain segment and certain aspects of reality. These could be galaxies, the fossilisation of organisms, earthquakes, the brain, the world economy, the cognitive performance of dolphins, the Turin shroud, or whatever it may be; nothing is safe before the serendipity of the scientist. While the scientist experiments, observes and measures, they collect the observational data for such a segment of reality. The observational method and data constitute the first components" (DIE ZEIT 37/1999).

The margins of experimental science are, in this sense, surrounded by challenges to *Bildung* which can only be accepted or given up, but never rebuffed, for the world, as shared [*geteilte*], can never be completely copied into an experimental space (or that which becomes an experimental space) that divides the world.

Not even a single element of the world can be copied into an experimental system—not only because a copy presumes the self-identity of an element,[64] but also because the construction of a world within a world continually alters the referential structure within which an element is initially assigned a meaning at all. Michael Callon calls such a referential context, which can also be an experimental system, an "actor-world" and describes the constitution of such a world in his (actor-network-theoretical) words as follows:

> An actor-world associates heterogeneous entities. It defines their identity, the roles they should play, the nature of the bonds that unite them, their respective sizes and the history in which they participate. But actor worlds must not be represented as shoppers in a well-stocked supermarket choosing what they wish to buy from a pre-established list. Once an actor-world comes into being, it does not draw its entities from previously established stock. It is not constituted in the way a shopping cart is filled. In short, there is no world, or worlds, from which pre-existing elements can be extracted. Nor is there a world which guarantees that the combinations created by the actor-world are realistic. Actors may construct a plurality of different and incommensurate worlds. (Callon 1986, 24)

Callon here refers not only to the absent pre-existence of things beyond the referential structure, which, in the strict sense, may not be designated as semiotic in the linguistic sense, but also to the historicity of a world such as the experimental system, which both enables the integration of things, while limiting those things which can be integrated.[65] For, an experimental system is not a collection, but rather, to use an appropriate concept from Latour, an *assembly* [*Versammlung*] (cf. Latour 2004, esp. pp. 53–90).

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[64] If one wishes to formulate this distinction using Deleuze and Guattari, one could speak of the task of charting a map and not a tracing. The "maps" of the world in the laboratory stand in no relation to the world either through "genetic axis or profound structure": their logic "consists of tracing, on the basis of an overcoding structure or supporting axis, something that comes ready-made."—"The rhizome is altogether different, a map and not a tracing. Make a map, not a tracing. […] What distinguishes the map from the tracing is that it is entirely oriented toward an experimentation in contact with the real. […] It is itself a part of the rhizome. The map is open and connectable in all of its dimensions; it is detachable, reversible, susceptible to constant modification. It can be torn, reversed, adapted to any kind of mounting, reworked by an individual, group, or social formation. […] A map has multiple entryways, as opposed to the tracing, which always comes back |to the same.| The map has to do with performance, whereas the tracing always involves an alleged |competence.|" (Deleuze and Guattari 2004, p. 13 f.).

[65] Explaining the experiment as an instrument of the task of representation (thus to attempt to explain it within the explorative system of thought), means abstracting from the process and placing the imagined result at the beginning. The inappropriateness of this idea of representation is evident in the context of other creative work. For example, Balthus brought inadequacy of this attempt at classification to a head with riposte question to an interviewer's question in which a critic insisted on the representational character of art: "The presentation had thus already taken place?" (Quoted from Roy 1996, p. 17).

An experimental system does not consist of elements lying side by side, which have nothing in common except for the place where they are gathered together. It rather consists of elements which must be brought into an iterative connection—and that means that they must operate with one another, or be able to interoperate. While a collection actually mediated through a concept, an idea, a classification or a theory is bound in a more or less successful manner (so that the "with" exists on the level of the concept, the idea, the classification or the theory between their respective elements—between something such as aspects, thoughts, criteria, concepts, and thus *other* elements), but the collection does not collapse, even if it proves to be eclectic (just as no museum collection could be made to fail if Bansky added inappropriate-appropriate pictures to the collection[66]), the connection (the with) of the elements within an experimental system is not mediated via the detour of a theory as it is the system itself that constitutes meaning (whereby theory does not, of course, become superfluous, it is unimaginable to construct a complex context without the abstractive function of theory).

The experimental system must, on the level of its elemental context, which the theoretically trained experimenter is not outside of, itself function—wherein the possibility of failure is inherent (and, even then, when failure is theoretically not accounted for).

So while it is possible to copy the *distinction* between the disclosed and undisclosed on the side of disclosedness (and, corresponding to this, the distinction between artificiality and nature), because it concerns *the same* distinction, it is practically impossible to copy the world as a totality into the experimental system in order to analyse a segment of it there.

The world as such, and its elements, cannot be copied at all, but one can also not be satisfied with bringing, in its stead, descriptions of it into the laboratory (and this because the experiment is not secondary to exploration, but rather presents an independent form of world-disclosure), because one would then only be dealing with one's own communications. But, because it directly concerns creating possibilities for the communication of something which one does not yet know what it is (or will have been), one must change the world, and work upon it, in order to bring it into the laboratory.

One must dissect it, carve it up, one must genetically manipulate it, radioactively irradiate it, accelerate its particles to the speed of light, or centrifuge them at 105,000 times the acceleration due to gravity; all this serves to modify something so that it can be grafted from one context into another, by making it possible to integrate it into an iterative event.

This not only assumes a comprehensive knowledge of the meaningful relations of the elements involved, but also the form of the orderliness which an experiment presents, which can easily be incorrectly taken for the "controlledness" of an experiment by an observer. However, it actually concerns a targeted effort at a loss of control, in the attempt to give up control of things—and this to such an extent that

[66] http://www.banksy.co.uk. and http://www.youtube.com/watch?v=EkUbYBo5xgs (both from 10. 08.10).

the experimenter may be surprised at who has here taken over control, but not in such a way that their trace is lost in the rush of the world.

The things should certainly take hold of the rudder; one could metaphorically thus describe it, but it should also be the rudder belonging to the experimental system. In order to enable this, it is crucial what is brought into the interior of the experimental system, and in what manner (interior: that is the experimental system itself), and what is left outside. If one here distances oneself to both the idea of a pure self identity of an element in the philosophy of presence, as well as from that of a homogenous space of meaning, then the integration of elements in an experimental system is more or less problematical, but it can never be thought in the absence of *différance*. " I shall try to show […] that there is no linguistic sign before writing", Derrida writes (1997/1967, p. 14). If no element can be integrated in a simple manner, then the integration of elements in an experimental system is necessarily subject to an act which, on the basis of the material-semiotic constitution of the experimental system, and in contrast to representation in exploration, can only be understood as an act of *translation*.

3.8 Representation and Translation

Michel Serres begins his third Hermes volume carrying the title "Translations" with the description of the basic functions of translation for every knowledge acquisition process:

> We know things only on the basis of the transformation systems of those quantities in which they are held. There are at least four such systems. Deduction in the mathematical-logical area. Induction in the field of the experiment. Production in the area of praxis. 'Transduction' or translation in the space of the text. It is in no way absurd if we assume that they repeat the same word. That there is philosophy only as the philosophy of *Duction*—together with the necessary, but exchangeable prefix. One could spend one's life explaining this matter. At the bonfire, in the light of seduction. In fact, our ancestors had a better word for it: *déduit*—amusement. (Serres 1992, p. 7)

Translations are no longer understood as being merely pragmatically necessary for overcoming language barriers in other areas as well.

Jean Delisle and Judith Woodsworth, for example, see translation as the most important factor in cultural change (Delisle and Woodsworth 1995). And Callon, who extends the translation concept considerably beyond its traditional linguistic meaning, places translation at the centre of his actor-network-theory when he writes of the manner in which elements become integrated in an "actor-world". He writes of the shift of meaning as a result of a "change of context": "Translation builds an actor-world from entities. It attaches characteristics to them and establishes more or less stable relationships between them." (Callon 1986, 35 f.) And, elsewhere, he summarises translation more precisely as a process: "during which the identity of

actors, the possibility of interaction, and the margins of manoeuvre are negotiated and delimited." (Callon 1999/1986, p. 68)[67]

No experimental system can achieve stability if it is not successful in bringing the elements involved together through their translation, in which it becomes possible for them to share [*teilen*] a world. Karin Knorr-Cetina writes, admittedly unnecessarily harmoniously, but still apt for the connection between translation and the experiment, about the laboratory being an intensified environment (Knorr-Cetina 2002, p. 45), in which "natural order is brought into harmony with social order" (ibid., p. 45). According to Knorr-Cetina, this requires a process in which both nature and the researchers "who serve as embodied instruments by means of their trained hearing and seeing" (ibid., p. 52), must be "adapted" to the function of this network.[68]

And, in an oft quoted text from the actor-network-theory, Callon describes how a group of biologists collect three utterly heterogeneous actors (also cf. very brief Ahrens 2005, p. 96 f.): French scallop fishermen, who were struggling with the problems of overfishing and competition from scallop larvae eating starfish, the hitherto largely unresearched scallops themselves, and the scientific community whose interest the biologists were trying to attract. "At the beginning, these three universes [the fishermen, the scallops and the scientific community] were separate and had no means of communication with one another. At the end, a discourse of certainty has unified them, or rather, has brought them into a relationship with one another in an intelligible manner." (Callon 1999/1986, p. 81)

Not just the simple collection of heterogeneous elements, but collecting them in such a way that they can share a common world, requires the translation of their communications. The researchers could not initially speak for all those concerned, so that all they had to do was to simply mediate, but rather only at the end of the research project. The possibility of representation is the result, not the precondition, of such a translation process.

Latour describes such a translation process in an earlier text as negotiation, in the course of which the intentions (in the sense of interests, or more precisely, as "explicit interests" cf. Latour 1987, p. 118) of the actors shift ("drift of intentions"), and so emphasises the political dimension of translation, and the impossibility of understanding translation as the "subjective" act of a single actor, a representative, or simply as the unproblematic act of a sovereign subject (cf. Latour 1988a, p. 34).

Callon terms that which shifts (*trans*ferred and re*placed*) in the course of this translation, the "interests"[69] of the participating actors. In this case, as the result of

[67] When Callon speaks of "actors" then this does not mean exclusively human actors. So in the following example apart from the scientists, scallops (*Pecten maximus*) and French scallop fishermen were also described as "actors".

[68] On the mutual adaptation of humans and machines as a challenge which can also fail cf. Pias 2003.

[69] It is possible that one can here translate "interests" with Spencer-Brown's concept of motive, and in this sense place theoretically deeper. Then Spencer-Brown explains motive as the essential moment of non-arbitrariness referencing the "co-mmunicator" that must be thought when making such a distinction. Spencer-Brown formulates this simply and paradoxically thus: "There can be no

a trial and error tinkering with the various possibilities opened up by the invention of a net protecting the settlement of the larvae from the starfish, this subsequently became the knot of "interests" of the various actors.[70]

The fishermen admittedly no longer fish for scallops, but now they can collect them; the scallop larvae can no longer move around as unhindered as before, but now they are safe in their settlement, and the scientists can announce the hitherto unheard communication from the scallops, that they prefer, in the form of their larvae, to settle; in the end, the performance of the translation enabled the researchers to speak in the name of the most different actors.

It becomes clear just from this simple example that, here, a neutral, interest free, "knowledge", is not concerned, for failure would, in this example, have had consequences for all those involved. The scientists would have had nothing to say to their community, in the course of time the fishermen would no longer be fishermen, and the scallops would have quite possibly disappeared.

Callon points out that this translation would not have been possible if one had understood the participating actors as self-identical entities: "[I]t would be absurd for the observer to describe entities as formulating their identity and goals in a totally independent manner. They are formed and are adjusted only during action." (Callon 1999/1986, p. 71) Whether such a process of translation will be successful cannot be previously known, nor how one reaches one's goal, and neither which path one thereby treads. Correspondingly, Callon's description of the negotiation process undertaken does not read like the interplay between theory and praxis, but rather as a didactic play about situational practical skills, which could be rudimentarily paraphrased with *metis*, but describing it precisely is extremely difficult, the Western tradition lacking the vocabulary to do so, as François Jullien has convincingly demonstrated (Jullien 2004).[71]

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distinction without motive and there can be no motive unless contents are seen to differ in value." (Spencer-Brown 1969, p. 1).

[70] "Composing poetry like translation therefore always also means exploring the possibilities of language in an experimental manner—and thereby transform the possible into reality, the unusable into the useful" writes Porombka, rolling this argument out from the other side (1999, p. 57), and one does not even need to add: "and the possibilities of technology", for at this point Porombka speaks of the possibilities of so-called "combinatory machines", with which one can recombine words, parts of words and sentences.

[71] This is why there is also the tendency to assume either a plan, or a "trial and error process" driven by mere chance. Marcel Detienne and Jean-Pierre Vernant write of *metis*, which is closely related to *techné*, that in the Greek tradition it gathers under it a mix of "flair, sagacity, foresight, adaptability, pretense, resourcefulness, vigiliance, opportunism" (Detienne/Vernant quoted from Jullien 2004, p. 7); thus Odysseus is characterised as *polymetis*. In contrast, Jullien convincingly demonstrates that it does not suffice looking for appropriate concepts in the Western tradition and that while *metis* does appear now and again on the margins of the tradition it is never explained or even theoretically grasped. In order to explain what here is even approximately circumscribed by *metis*—and, strictly speaking, the same also counts for *techné*—one must go beyond the Occidental tradition. By comparing how classical Greek and classical Chinese philosophy thinks *efficacy* he demonstrates the limitations of Western thought, which is especially convincing because he refers to those fields in which the thought of the plan, the model, anti-praxis oriented theories, pre-existent properties etc., systematically fail: war, political power, and persuasive speech.

Describing the integration of elements in an experimental system, and the gathering of actors in an iterative event, as a process of translation, is more than just a metaphor based on the activity of the translation of a text, or a word from one language into another. Rather, it is the explicit extension of the traditional concept of translation, restricted as it is to the linguistic, which is intended.

For that which, in the course of the constitution of an experimental systems, is brought inside from outside was, of course, not previously beyond all meaning, outside of the world, but rather always already within a material-semiotic space of meaning (which, as a space of meaning, cannot have been the *undivided* [*ungeteilte*] world in itself). Thus, that which has been brought inside from outside can previously also have been found in other experimental systems and nowhere else; but certainly as a part [*Teil*] of a world already divided [*geteilten*] through experiment.[72]

For, even if one intends researching something as natural as liver cells, one cannot extract them from a previously undivided [*ungeteilten*] world, or even take them from a "life world", since, without mobilising the artificial setup of a laboratory, they would not, as such, even care to make an appearance.

The meaning of translation in the experiment is not immediately obvious; it is not to be exploratively disclosed at all. Thus, in the course of the explorative approach, the earlier work of the more recent research into science and technology admittedly saw that the work in the laboratory functioned totally otherwise than described in classical philosophy of science, or, as claimed by the participating actors after work. However, the researchers, as crisis theoreticians of the explorative, remained trapped in the absence of a fundamental distinction between science and non-science.

They observed and described the processes in the laboratory, and thereby attempted to maintain their distance and not become involved in the events. One can understand from the earlier research by Knorr-Cetina, Latour and Woolgar, as well as the studies of the strong programme (Bloor, Barnes), how their explorative manner of going into the labs and describing what they found there, led to them falling into a discovery-exposing bearing, which mainly exhausted itself in the insight that the presentation is something other than the presented.[73] The uncontrolled reactions to this are, in the meantime, history.[74]

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[72] "We will never have, and in fact have never had, to do with some 'transport' of pure signifieds from one language to another, or within one and the same language, that the signifying instrument ['*vehicule*'] would leave virgin and untouched." (Derrida 1972, p. 20).

[73] A current example is the contribution by Claudia Niewals-Kersting, "Images of Life" ["Bilder des Lebens"] (2009), in which she also cannot suppress an exposing attitude when she complains about the mixing up of pictures with reality, instead of investigating their constructive function in the knowledge acquisition process herself.

[74] For a sociologically related debate on science research regarding "social construction", or the so-called Science Wars cf. Ross 1995; Sokal 1996; Fromm 1997; Moseley 1998; Sokal and Bricmont 1998 and, for an overview, Ross 1996. The attitude of Hans-Magnus Enzenberger, who, from an apparently neutral stance, attempts to protect his admiration of the exact sciences from being exposed, does not stand alone. Not when he disputes the relation to reality of the probability calculating research (and in an abridged interpretation of system theory) (cf. Enzenberger 2009, as well as here p. 185), and not when he recommends those sciences allegedly obliged to the presence of the world as a singing defence against the pretensions of the science researchers (Enzenberger 2000).

With their explorative approach the researchers of science fell back behind that which they were researching. It was firstly Rheinberger who methodically put into practice what he observed as the object of work in the history of science. This is why one can term the *translation* as Rheinberger's most remarkable achievements, analogous to Derrida's commentary of Lévi-Strauss (also see Sect. 3.18).

Rheinberger namely attempts (without himself putting it that way) to translate, as appropriately as possible, what he had reconstructed in the laboratory, with the help of just that which he tried to translate as appropriately as possible.[75] This is insofar appropriate in that the work in the laboratory is mainly the work of translation, and experiments are based upon nothing other than the translation of translations. [76]

The philosophy of science had asked itself how insight enters the scientist's texts, as if it were the only decisive interface in which senseless data is first brought into a context constitutive of sense.[77] In contrast to this, Rheinberger was interested in the interlocking, nested interfaces, which, no longer as in earlier times, ran between text and instrument, life and technology, or wet and dry, but rather right through all these (one thinks, for example, of the Drosophilae mutants that are not themselves—in any case, no longer—epistemological objects, but rather instruments to chart genetic maps with). The decisive context, constitutive of meaning, is the experimental system on the level of its materiality itself,[78] not first the technical article.

Rheinberger holds that, within the experimental system, and, above all, in the history of the experimental system, and the path of change which the things of the world must follow before they can be introduced to this system, one can distinguish layer upon layer of translation. One could say that Rheinberger simply outlines what it means to understand the element of an experimental system as a grapheme, which is constituted in the execution of the experiment itself.

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[75] Thus both Derrida's Of Grammatology, as well as his account of work in the laboratory, which he translates into a social scientific language. Regarding translating Derrida and the translations of Derrida also cf. Rheinberger 2006a.

[76] Rheinberger occupies himself with biology, while classical theories of science most often deal with physics. It is obvious that the choice of the field of objects is not arbitrary. It would be just as difficult for Rheinberger if he undertook the example of Einstein's reformulation as he had by taking the example of protein synthesis in the test tube, or just as Popper would have found it difficult finding his examples in the realm of biology. However, times are changing. Ian Hacking pointed out in a lecture after visiting CERN and SLAC that, in current physics, theoreticians and experimenters are more strongly dependent upon one another than ever before, and emphasise this independently of each other (Weizsäcker Lecture in Hamburg on 28.11.2005).

[77] However, Rheinberger remarks that the overvaluation of this interface is also to be found in Latour's work (1997, p. 111).

[78] Otherwise one could not avoid an idea of a presence (or solipsism), whereby the historicity of the experiments would collapse: "Since the trace is the intimate relation of the living present with its outside, the openness upon exteriority in general, upon the sphere of what is not 'one's own' etc., *the temporalization of sense is, from the outset, a 'spacing.'* As soon as we admit spacing both as 'interval' and as openness upon the outside, there can no longer be any absolute inside, for the 'outside' has insinuated itself into the movement by which the inside of the nonspatial, which is called 'time,' appears, is constituted, is 'presented.' Space is 'in' time; it is time's pure leaving-itself; it is the 'outside-itself' as the self-relation of time." (Derrida 1973, p. 86).

Technology is, in this description, a medium of knowledge, not because it checks something, or that one can see through it, but rather because it is that medium in which it becomes possible to materialise questions in the form of an experimental system (Rheinberger 1997, p. 28).

Although Latour himself resorted to a discovering/exposing attitude in his earlier work, he still already saw the necessity of emphasising the task of translation as a central component of experimental scientific work, freeing it from the restrictions of the linguistic understanding. In *Science in Action* at one point, concerning the attempt to transport heterogeneous actors into a common context of interaction, or, more precisely, the failed attempt in France, in the eighties, to bring together firms, scientists, batteries, politicians etc. in a common project for the development of an electric car, he writes:

> It should now be clear why I used the word *translation*. In addition to its linguistic meaning (relating versions in one language to versions in another one) it has also a geometric meaning (moving from one place to another): Translating interests means at once offering new interpretations of these interests and channelling people in different directions. 'Take your revenge' is made to mean 'write a letter'; 'build a new car' is made to really mean 'study one pore of an electrode'. The results of such renderings are a slow movement from one place to another. The main advantage of such a slow mobilization is that particular issues (like that of the science budget or of the one-pore model) are now *solidly tied* to much larger ones (the survival of the country, the future of cars), so well tied indeed that threatening the former is tantamount to threatening the latter. Subtly woven and carefully thrown, this very fine net can be very useful at keeping groups in its meshes. (Latour 1987, p. 117)

And, at another point, in a presentation of the concerns and procedures of the actor-network-theory, he describes the fundamental meaning of the concept of translation in the attempt at turning sociology on its head. It is the attempt to make out of the *explanans* "social", the *explanandum* "social", which moves Latour to understand translation as the weaving of associations between actors, which cannot be attributed to something lying behind it such as pre-existent structures:[79]

> [T]o use the word social for such a process is legitimated by the oldest etymology of the word *socius*: 'someone following someone else', a 'follower', an 'associate'. To designate this thing which is neither one actor among many nor a force behind all the actors transported through some of them but a connection that transports, so to speak, transformations, we use the word *translation*—the tricky word 'network' being defined […] as what is *traced* by those translations in the scholars' accounts. So the word 'translation' now takes on a somewhat specialized meaning: a relation that does not transport causality but induces two mediators into coexisting. […] [T]here is no society, no social realm, and no social ties, *but there exist translations between mediators that may generate traceable associations.* (Latour 2005, p. 108)

Latour's examples of the transferral and replacement of "interests" between human and non-human beings, the *translation*, mainly come from the area of the sociology

[79] Indeed, the examples showing the social consequently maintained as *explanandum* and not introduced under hand as *explanans* are rarer than one might initially think when looking at the simplicity of such an approach. That Latour is consequent in this respect is perhaps also the reason for Dirk Baecker's surprising conclusion that Latour's outline of a sociology "matches up with that which Niklas Luhmann proposed with his system theory." (Baecker 2007).

of technology. Thus he speaks of the transferral of the interests of children not to be run over by cars travelling too quickly, which is transferred via the police to the Department of Civil Engineering to a marked increase in the height of pavement curbs. Here, the driver's lack of interest in driving slowly is replaced by the interest in not damaging the car bumpers, mediated[80] by the characteristics of the street. This thus brings the interests in not ruining one's own car together with those of the children, in not being run over (Latour 1999b, p. 187 ff).[81]

No compromise, no discourse free of domination, no moral appeals, are here responsible for bringing together the differing interests of two previously adjacently existing actors, but rather a ruse, achieved by translation. If Latour speaks of translation achievements in relation to scientific work, then not in order to say something explicit about the constitution of experimental systems.[82] However, his field work still helps in understanding the meaning of translation in the constitution and processing of experimental systems. With the help of his translation concept he outlines the transformative path a part of nature must follow if it is to be integrated into the artificial setup of the laboratory.

Latour describes that which remains through all these steps of translation, in a doubled demarcation from essentialist representation and (optionally social or linguistic) constructivism, as "Circulating Reference" (Latour 1999b, pp. 24–79, esp. p. 58).[83] Just like Rheinberger, Latour also sees every single one of the translation steps, of which the last one is the step to the scientific article, as being "risky" (ibid., p. 53).

When the talk is normally about translation in the narrow, linguistic sense, then a text is also always presumed in the narrow sense, and thus a pre-existent separation between the semiotic and the material, with the semiotic being prioritised over the material. The deciding epistemological question is, therefore, always the question as to how one can express in language what one finds in the world, irrespective of the ability of those non-human actors without language competence to communicate, according to the linguistic sense.

Latour follows the path of this circular reference[84] from the other side. Unlike Rheinberger, it is not the iterative event in the experiment that interests him (Latour

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[80] For more on this concept also cf. Latour 1999b, p. 178 ff.

[81] The example of the "sleeping policeman" as the humps are called in France can also be found in Callon and Latour 1992, pp. 361 ff. Further examples of this type of translation achievements can also be found in Latour 1996. Further, more extended, examples with detailed methodological-theoretical reflections on the concept of translation can be found in Callon 1980, 1986, and 1999/1986.

[82] Latour did not theoretically specify the processes in an experiment as Rheinberger did, and he did not have at his disposal a distinction which clearly delimited the experiment from everything else, such as is done here using the distinction between experiment and exploration.

[83] On the meaning of translation and the concept of translation in Latour's work also cf. Latour 2008. For a further example of the use of the concept of translation and mediation cf. Latour 1999b, pp. 174–215.

[84] Latour points out that "reference" is derived from the Latin referre, which also means to produce (Latour 1999b, p. 32).

does not use the concept of iteration), but, nonetheless, the steps of alteration in the things themselves do interest him. More precisely, the steps of alteration to which things are subject to when they are brought from outside into the laboratory, and are then again taken outside from the laboratory, as well as the stages of alteration that things are subject to when they are integrated within the laboratory, or between laboratories, in the various apparatus and procedures.

In a speech on the occasion of the awarding of the Unseld prize, Latour draws a direct connection between his discussions of the problem of Bultmann's exegesis of the bible at the beginning of his scientific career, and his laboratory research. In both cases, one had to do with a "network of translations" (Latour 2008, p. 3). Both cases were concerned with a number of translations, a "work of interpretation circling around barely perceptible traces" (ibid., p. 4) which filled the space between "mere invention" and "immediate certainty".

He does not follow a process of semiotic reinvention by the scientists on the way to new insights; the process how scientists get to see something new in that they create innovation in theory, or even only in language, does not concern him. Neither do the changes to language which must occur if something new is to be thought and seen concern him. It is rather the changes of the things that must come to pass in order to give them a scientifically processable form, or, one could say, in order to transfer them to a scientific discourse (no matter the discourse in which they beforehand stood).

One of his simplest and clearest examples is that of an Amazonian expedition. If one wishes to compare the vegetational zones on the edges of different rainforest regions, one cannot do it simply by laying them side by side, they are simply too large for this. What one can lay side by side are soil samples—as *pars pro toto*—which can be placed on a transportable device with standardised fields (a pedocomparator). All further steps which are then undertaken are directed, not toward the vegetational zones themselves, but rather toward the contents of the pedocomparator. From here, parts, or aspects, of these soil samples, such as, e.g. their colour, are transferred to tables by means of a colour screen, or the many soil samples are classified according to the grade of their clay and sand components by means of the trained sense of the scientist as s/he crumbles the earth in his/her hands (Latour 1999b, p. 63 ff.).

The extent of these transformations that the things are subject to perhaps becomes clearer when one takes a look at the bio-sciences with their preparative processes, which stretch from the immersion of a single example of a species in formaldehyde in which the bodily fluids are exchanged, and then the exemplar stands for a whole species, via radio-labelling, in which a single atom of a molecule is replaced by a radioactive isotope, to the analysis of a genetic sequence, in which the resulting gene mapping stands in no understandable relation to the original product for the layman.

Rheinberger here distinguishes between "mainly descriptive, systematising science", which detaches things from their original contexts, and transforms them as a part of, among others, collections, herbaria etc. to epistemic objects in theoretical categories, from the experimental sciences, in which the preparation of the things is even more radical and stands in a direct connection with technological development: "this preparation of the things is often directed by the development of certain

instruments for observation and measurement, which, in a certain way, mediate between the prepared object and the device based insight as an equally important third" (Rheinberger 2006b, p. 336).

In contrast to models, preparations actually serve *as* epistemological objects (ibid., p. 338). In the chromatograms of modern biology the scientist finally only sees the traces of the things: "in that the technical process does not simply record the things, but rather graphically reconfigures them, it writes itself into the preparation or sample and *infiltrates* the object under investigation" (ibid., p. 346).

Here, at the very latest, technology can no longer be understood as being externally added to the object. This is also the point which astounded the early researchers of science: that that which is worked upon in the laboratory is not the same as that which it stands for at all (or, as that which it should be). This point of view, understanding the alteration of the world from the side of the things, allows Latour to reformulate the concept of translation as well as the concept of reference, namely, not as "some material guarantee for the truth of a statement; rather it is our way of keeping something *constant* through a series of transformations. Knowledge does not reflect a real external world that it resembles via mimesis, but rather a real interior world, the coherence and continuity of which it helps to ensure" (Latour 1999b, p. 58). "*The word 'reference' designates the quality of the chain in its entirety*, and no longer *adequatio rei et intellectus*" (Ibid., p. 69).

That Latour here speaks of something constant being maintained is as misleading as it is unnecessary.[85] In contrast to this, the restriction of an "interior world", and the description of the necessity of (technological) invention on the path of the translation, reminds one of the moment of discontinuity that José Ortego y Gasset emphasises in his classical essay on translation, *The Misery and the Splendor of Translation* (1992/1937), as the impossibility of the task of the translator at the same time being the condition of its possibility. If translation were not impossible then a translation would not be needed—because if a single, overarching language does not exist, then the rules for translation cannot exist, which is also why it cannot be delegated to a machine.

Not one of the translation steps described by Latour or Rheinberger can be understood in terms of the application of a rule, not one of these steps of translation is based upon a common foundation, just as there is no universal language transcend-

[85] It reminds one of a similarly ambivalent reference to a "continuum" in translation in an early text by Walter Benjamin, in which he writes: "The transport of one language into another through a continuum of transformation. Continua, not abstract precincts of equality and similarity strafe the translation" (Benjamin 1991, p. 151).

ing all foreign languages which could provide fundamental rules for translating between e.g. French and German.[86] That is why every translation is risky.[87]

That this is so is not a new insight.[88] The breach between the individual steps of translation, as one could very reductively summarise the far reaching problem of translation, must be traversed in an understandable fashion, without being able to thereby guarantee any sort of constant. However, this intelligibility can only be guaranteed when one restricts the circle of witnesses, the circle of those to whom the task of comprehension falls, to those persons who are also in the position of being able, or are granted as having the ability, to translate and comprehend.

The ability to feel and classify with one's bare fingers the percentage of clay in a soil sample, as Latour heard from the researchers of tropical regions, alone requires years of practice. In order to be able to make a connection qua translation, a division [*Teilung*] must also come about at the same time, namely between the "competent", and the "incompetent". The connection provided by the translation is achieved through a division [*Teilung*].

This is also what Ortego y Gasset pointed out in his retort to the most obvious objection, that the "language of science", and especially the language of mathematics, is clearly universal, transcending languages, so that here one hardly needs to translate. From this, so the argument goes, it is hardly to be expected that the meaning of a mathematical proof is decisively different when it is translated from a French article into German, whereby the translation of a scientific technical paper about thermodynamics also appears to be considerably easier than the translation of, for example, a Shakespearian Sonnet.

Ortega y Gasset retorts that the translation only appears easy to those who believe translation takes place only between national languages—as if one was no longer confronted with a problem of translation when one was concerned, for example, with bringing the laws of thermodynamics together with a concrete problem of application.

One cannot solve the problems of climate change in the laboratory alone, even if one was successful in silencing all those incompetents. For those who claim to always cling only to the hard facts, and see no necessity for translation, exactly

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[86] If there is no possibility of stepping out of language, to translate from a place beyond language, between two languages, and it is then still possible to translate, then there is, strictly speaking, only a single language; whereby one has next to one another both laws of linguistics which appear contradictory in themselves and against one another, which Derrida suggests as the conditions of possibility for thinking any translation: "1. We only ever speak one language. 2. We never speak only one language." (Derrida 1998, p. 7). Cf. also the last footnote in Sect. 3.3.

[87] In Gadamer's hermeneutics, one could argue (cf. Koller 2007b, p. 62 ff.) that the continuity of sense through the various interpretations (and translations) is emphasised, while Derrida concentrates on discontinuity (cf. esp. Derrida 1977).

[88] Which, however, does not mean that there is an established study of translation to which one could thus readily refer to: although there is a science of translation with all the characteristics of an established discipline (conferences, journals, professors, courses etc.), it is at the same time stamped with the absence of an internal coherence, as Zybatow (2004) noted in his summary of this young science; above all there is missing every relation to scientific theory. Cf. also Fabricius-Hansen and Østbo 2000.

"those facts that are expressed as a number, a column of numbers, or a mathematical function", count as "hard facts", writes the mathematician Claus Peter Ortlieb (2006, p. 164), and additionally describes what is actually described by the hardness of these facts—namely nothing:

> Nothing yet has been said […] about their meaning. In experimental science, it arises from the technical manufacturability, i.e. precise instructions, with which the claimed results are achieved. Therein lies the whole secret of the 'precision' of the mathematic-scientific method. In the transferral to areas of knowledge in which experiments are not possible, but rather the connection to empiricism lies in the non-interventional observation, or the statistical survey, this 'precision' must be lost. What replaces it remains unclear. (Ibid.)[89]

When numbers, technology, and phenomena, *within* a material-semiotic space that is de-partmentalised [*ab-geteilten*] from the world, refer to one another, and can be repeated in their ideality, there emerges not simply the impression of an undivided [*ungeteilten*] space, in which every form of alteration in the iteration can be forgotten, it is, above all, also the de-partment [*Ab-Teilung*] of the world that has been forgotten, and thereby the necessity for translation. If one forgets the translation services that were necessary to get the experiment up and running, and extrapolates the impression of the undividedness of the experimental systems in the world, then one must naturally wonder at how well it all comes together: "It's pure magic!", cries an accordingly enthusiastic Dewdney, one of those who believes that exact sciences should be protected from the disenchantments of the philosophy of science, and extends the connection between positivism and magic even further: "Real science […] remains genuine magic. It is fascinating to see how many physical phenomena remain true to theory and formulae with uncanny precision, which has nothing to do with our wishes and creative impulses, but rather with pure reality." (1998, p. 30, quoted from Ortlieb 2006, p. 159).

However, the description of the necessary transformations in the construction of an experimental system, of course, does not present a form of disenchantment, in which the results of science are recognisable as mere constructions "according to our wishes and creative impulses". It rather presents them as translations, as a transferral and replacement, "a transformation of one language by another" (Derrida 1982, p. 14).

Because translations are in no way arbitrary, but must rather be understandable to qualified witnesses, the question of "correspondence" is shifted to the qualitative field. No-one would have the idea of judging a translation of Homer on whether it fully matched the original, *or* whether it was freely made up. Rather, it would be sensibly evaluated as to whether or not it was successful, whether or not one can make use of it.

This presents the solution to the unsolvable problem of translation as a variation on Boyle's solution of scientific evidence. With an eye on the explicability of the activity, and of one's own conclusions to *others*, and under the inclusion of an element which is, in itself, imprecise, a merely probable and only sufficiently appropriate result, one arrives at an equivalent of the truth. This is recognisable as

[89] I thank Felix Bracht for the reference to Ortlieb.

being deeply social and historical in nature, which can only be understood against the background of a division [*Teilung*] (not everyone can understand everything) of a shared [*geteilten*] world (the trans-lation is an immanent task, without reference to an overarching transcendence). Homi Bhabha emphasises these ruptures in another, but nonetheless relevant, context, in an equally apt way:

> [T]ranslation is also a way of imitating, but in a mischievous, displacing sense—imitating an original in such a way that the priority of the original is not reinforced but by the very fact that it can be simulated, copied, transferred, transformed, made into a simulacrum and so on: the original is never finished or complete in itself. (Bhabha and Rutherford 1990, p. 210)

In another place, Latour also emphasises rupture rather than constancy: "Here it is no longer a question of reduction [along the path from soil sample to a number in the table of a text], but of transubstantiation." (Latour 1999b, p. 64)[90] Whether one arrives at a meaningful conclusion therefore depends upon the performance of those who built the pedocomparator when one speaks about the soil samples from the respective soils. This is exactly the same as whether one, not being fluent in French, when speaking of Derrida's *Of Grammatology*, depends upon the performance of Gayatri Chakravorty Spivak [in German—Rheinberger and Hans Zischler].[91]

And, it depends upon the performance of those who draw upon *this* translation in judging whether one can forget it, or whether it needs to be altered. (A performance which in no way necessarily presumes full knowledge of both discourses; the close familiarity with a discourse already brings with it a feeling for the quality of the translation).

And, of course, it is not just a single device that mediates between the laboratory and the world, but rather a number of devices which can mutually confirm or contradict each other, just as there are a number of researches which use these devices

[90] It is probably a legacy of old European thought having a problem with transubstantiation (in the sense of a translation back and forth, not in the sense of a magical wafer). If one is accustomed to deriving the essence of things from presence, then the impression that the essential is lost when one changes the medium necessarily emerges. A cultural comparison can make this clear: Europeans are, at the moment, expending considerable efforts to rescue the architectonic legacy of ancient Athens through careful restoration and maintenance and considerable financial support from the EU. And indeed, it would be a very real experience of loss to Europe if the attempt at protecting the Acropolis for the next generation from Athens' exhaust fumes fails. If one, in contrast, looks at Japan's handling of its most important Shinto shrines, the Ise Jingu in the Mie Prefecture, as a European one can only rub one's eyes. The shrine, also 2000 years old, is not spared, but rather still used according to its purpose, and is visited yearly by several million guests who eat, bathe and pray there. The shrine is built from materials such as wood, which is anything other than durable (there are not even nails)—and still looks like new. How is that possible? Through transubstantiation. This most important building is maintained by regularly raising it to the ground. From around the year 500 the shrine has been burnt down and completely rebuilt every 20 years (with the exception of war. War, of all things, meant that the shrine would, by way of exception, *not* be destroyed). Written drawings do not exist. The building continues to exist in the heads and bodies of the craftsmen and is orally, and through imitation, passed on from generation to generation. (Cf. Tange and Kawazoe 1956).

[91] And just as experience sometime makes it possible to refute a useless translation, devices such as the pedocomparator can also be rejected, rebuilt, or replaced.

with varying degrees of skill, power and perseverance in order to use them more or less appropriately.[92]

3.9 Simulation and Virtuality

The "virtualisation" of science was once an important subject, and, with it, the question as to what reference to reality does science still have when it works with computer simulations. Today, when no responsible bridge builder can do without a computer simulation, the question appears as just another symptom of the crisis of explorative thought at the end of its universal validity.

Experimental work was never anything else than the work in a virtual space: one never works with the things in themselves, but always with a translation of a translation. Elena Esposito had thus shown that, always then when probability comes into play, the step into virtuality has already taken place (Esposito 2007)—and, as has been shown above, the invention of the experiment is the introduction of probability into the heart of the *episteme*.[93] The question is, therefore, not whether one loses the relation to reality when one observes something other than the object of research. The question from the perspective of the experimental system of thought is whether a possible translation is concerned ("virtual, adjective, perfect, foreign, 'possible'", Kluge 1999), whether the translation has the force and ability ("virtūs 'force, skill, manliness'", ibid.), to take the place of the translated.[94] There is no difference, in principle, whether the translation is now into a computer readable format, into a table on paper, or into a pedocomparator, except, with respect to the medium, the number and the size of the steps in translation.[95]

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[92] For, as Latour's account makes clear, the filling of a pedocomparator requires ditches, spades, measurements, mixing and so on. The path of the soil into the comparator already presents a translation.

[93] However, an unqualified admirer of the exact sciences such as Enzensberger sees that as proof that one must either work with probability and thus with fiction *or* with truth, whereby the work with probability can at the most have a therapeutic effect against the suffering which can come from contingency (cf. Enzensberger 2009).

[94] Cf. also Merz on the use of simulation software: "The reliability of the data in the simulation is similarly questionable and disputed as in the experiment. While experimental physicists ask whether the apparatus actually did work on the basis of the known presumed mechanism and the results have not been distorted by a systematic error, simulation experts proof the state of their simulation programs. 'State' here describes the specific arrangement of object and the realised form of usage as the evaluation of a simulation program only makes sense with respect to a concrete application. Also, the consideration of simulation as an extension of the epistemological space forces itself upon an extended understanding of 'resistiveness': It is important to note that with respect to the configuration through recalcitrance and the withdrawal of control that the resistiveness of an object does not have its materiality as a precondition." (Merz 2002, p. 288).

[95] The idea of thinking virtuality together with possibility stems from Latour. On the connection between translation and virtuality also cf. Münker 1997, pp. 109–112.

Only within an explorative thought system at the end of its possibilities can the important, decisive, and *practical* question of virtuality, the question as to *how* one virtualises, become hidden by the question of the scientific legitimacy of virtualisation. "Virtuality" becomes used in such a discourse as an antonym to "reality". For example, in his book *Fake*, about artificial worlds and the increase in simulations, Manfred Geier equates virtualisation with phantomisation (Geier 1999, p. 158).

This is, from the perspective of an experimental system of thought, the universalisation of the standpoint of someone who cannot, or will not, understand the ruptures of the steps in translation—which, strictly speaking, is nothing other than the perspective of that famous professor from Padua (for more on this cf. the section regarding proximity and distance: 3.10). Geier's *Fake* makes clear the fascination of the explorative with failure, which, in its form, simultaneously identifies the explorative, as a universal, with science as a whole.

This is exemplarily shown in formulations such as these: "[Scientists] do not find truth, but rather invent their theories, in the hope of continually improving them, in order to be able to bring them nearer to reality" (Geier 1999, p. 159). Here, one has everything together *in nuce*: thought starting from theory, the claim for correspondence not being forfeited, the idea of finding the truth, and the inability to think of invention as a generative centre of insight—and, at the same time, the fascination that none of this works anymore.

That exploration still dominates thought is also suggested by the ease with which science fiction, with its explorative dreams of finding another, better world, is transferred to virtual space (cf. Rötzer 1997). Together with the last goals of classical exploration, the explorative utopias of better worlds have been shifted from the Pacific Isles, via space to virtual space.

That technology has, as a catalyst, brought exploration to just this end, and prepared the way for the invention of the experiment is one thing. That technology continually produces new, explorative, disclosable space—namely the space of technical possibility itself—and thus artificially keeps alive the explorative thought system as a universal, is the other, and it is this which is, to the highest degree, corrupting of *Bildung* (for more on this cf. Sect. 4.5).

3.10 Distance and Proximity

The natural science laboratory is a paradoxical place, in which the nightmares of the classically orientated philosophers of science come true. Here, one does not only extend one's knowledge by narrowing one's perspective, one also deals with nature by completely changing it. The observer would not simply have difficulties in deciding between being and appearance, as well as the natural and the constructed, s/he may well also have difficulties finding anything at all that has not been prepared and changed.

However, it is not just that technology changes, instead of remaining neutral and transparent as a medium, and that life is changed according to the stipulations of

technology, even the observers no longer observe from a neutral distance, but rather allow themselves to be involved in the events in a way which can be best described as intimate and affectionate bonding.

It would, however, also be correct—to make the difference to distanced, explorative action absolutely clear—if one said that one must makes friends with the experimental setup. This description is not too far-fetched, for example, experimental psychology is based on friendship, the friendship of Pawlow's post-graduates (described as *practicants* [*praktikanten*—trainees] in the laboratory) to their dogs.

The biggest risk for Pawlow was the unforeseeable psyche, and individual character, of his dogs (Todes 2004). The first challenge consisted of splitting the dogs into a technology, and an epistemic object, without killing them. Within the dog, that which must be forgotten as a technological constraint must be separated from that which should, as an epistemic object, become the object of knowledge.

In order to make this possible, each of Pawlow's *practicants* was respectively assigned a dog, which s/he had to get to know as well as possible to be able to distinguish what in the dog was typically dog-like, and which individual characteristics of the dog could be ignored.[96] The *practicant* had to e.g. know whether the dog salivated because it heard the bell, or because it thought of food anyway at this time. S/he had to know whether the dog liked the meat being offered at all, or, as was the case with some of the dogs, its mouth remained dry at the smell of e.g. turkey, or whether, and how, the dog reacted to bad moods etc. And all had to first learn to even participate in the experiment, and to thereby concentrate on the essentials.[97]

Only at the end of this *complex* process of coordination and mutual learning, when every dog could undergo its own experiment, personally tailored for the purposes of comparability, were the dogs so engineered, their reactions so disclosed, that Pawlow could take a step back, and observe from a distance, how *easy* it was to condition the dogs. Generally speaking, it is thus not possible to develop an eye for that which cannot be expected within an experimental system, if one has not beforehand made him/herself so familiar with the processes of an experimental system that one has developed a nose for everything that is to be expected.

It is not the naive wonder at the self evident, which has been stylised to a universal scientific virtue, that brings the experimenter to new insights, but, on the contrary, his/her heightened familiarity with the process of his/her experimental system, which, in the first instance, enables him/her to perceive deviations and surprises. It is also not an exaggerated pathos, but rather the attempt at describing scientific virtues as accurately as possible, when Rheinberger speaks at one point of a need for more xenophilia, "a certain love of the epistemic objects" (2005, p. 29).

Intimacy, in the sense of an acquired familiarity with the material-semiotic context of an experimental system, is also the precondition for every form of transla-

[96] On the training of the ability to make such distinctions, as a precondition of participating in scientific discourse cf. Daston and Galison 2007.

[97] On the bonds of friendship with non-human beings as a precondition of responsible scientific work also cf. Haraway 2000, pp. 123–126.

tional performance. In other words, it is utterly out of the question to translate from a distance; one must "involve" oneself with that which is to be translated.

Gayatri Chakravorty Spivak, like Rheinberger, a translator of *Of Grammatology*, speaks of the necessity of intimacy in the process of every translation. The translation of a text from another culture is, for Spivak, an act requiring a great deal of "intimacy" or proximity to the culture from which the text comes (Spivak 1993, p. 191). This goes beyond the normal meaning of translation as a "transferral of text" (ibid., p. 179). Just as Pawlow's *practicants* had to befriend their dogs in order to be able to translate their communiqués into a scientific discourse, Spivak envisages the necessity of the translator weaving a "bond of friendship" between texts.

According to her, a translator may not maintain a distance to the text, s/he must much more answer them—without, however, getting lost in them. Spivak, like Rheinberger, speaks without embarrassment of love, and refers to the political-ethical dimension of translation which accompanies the obligations of a translation, and makes it a task which is anything but a simple craft (cf. Spivak 1993, pp. 179–200). In an explicit reference to deconstruction—it compares translation with deconstruction—she writes at another point:

> Deconstruction can only speak in the language of the thing it criticises. So, as Derrida says, it falls prey to its own critique, in a certain way. That makes it very different from ideology critique […]. The investment that deconstruction has to make in the thing being deconstructed is so great that it can't be made simply as the result of a decision that something is deconstructed. (Spivak 1990, p. 135)

In other words, if, in the experiment, the disclosedness of the world is augmented right up until the limits of its completion through the closure of a space, in order to open up the possibility for an absent other [*Fremden*] to communicate through the strategic exploitation of the iterability of its material-semiotic constitution, and, as a consequence, one can no longer meaningfully talk of a "between" regarding the media involved in the event, so that one must see the technology involved as an equally irreducible medium of insight as language, and the necessity of translating in the immanence of a shared [*geteilten*] world has stepped into the place of the representation of an exteriority, then the distance to an object of knowledge becomes recognisable as a retrospective fiction, and the active division [*Teilung*] of a shared [*geteilten*] world becomes the epistemological condition of possibility of insightful knowledge.

The relationship to knowledge mediating technology can never be instrumental because one thinks within it, rather than with it. Simply using technology does not in itself lead to insights. One cannot maintain "critical" distance and neutrality in experimental dealings, if "maintaining critical distance" describes the attitude in which one does not allow oneself to become involved, or to be told something. In an experiment, one cannot maintain distance and avoid getting oneself involved—especially when it concerns thinking beyond the given state of affairs.

The art therefore resides in being able to acquaint oneself so well with the reactions and quirks of the things gathered together, and becoming so familiar with it that one can tune and connect it with other parts of the experimental system, and thus assemble it translationally, until it can be transformed into an iterative process

as a technological boundary condition, with which one must also familiarise oneself.

One could, with Bourdieu, say that the handling of an experimental system must be virtuosic (a decisive difference to purely mediatory technology, and a decisive difference to a handling of technology that now is often described as "indefinite").[98] Bourdieu writes, in a context that does not refer to the experiment, or to the handling of technology, but that certainly allows for the parallel to be drawn, that virtuosity presupposes a habitus "that so perfectly possesses the objectively available means of expression that it is possessed by them, so much so that it asserts its freedom from them by realizing the rarest of possibilities that they necessarily imply." (Bourdieu 1990, p. 57).

Because the intimacy, the involving of oneself, in the service of an active division [*Teilung*] of a shared [*geteilten*] world, stands in connection to epistemological interests, it neither intends the negation of the distance in the imaginary, nor the fusion with the object in which otherness [*das Fremde*] is rejected. On the contrary, it rather seeks the unearthing of an absent other [*eines Fremden*] in the event: being able to take distance to otherness would presuppose that the experimenter was dealing with otherness [*Fremden*], recognised as foreign [*fremd*].

As such, the intimacy in an experiment stands in the service of a strategy of *self-alienation*, and the alienation of one's own world, the world in which one lives and knows how to move virtuously; for, the experimental system is the augmentation of the disclosedness of a shared [*geteilten*] world, a world in which nothing more appears foreign [*fremd*] to one. Insofar as translation is the "transformation of one language by another" (Derrida 1972, p. 20), then it also concerns the transformation of one's own "world and relation to oneself" (if one still wishes to express it as such: cf. Sect. 4.4), an alienation, a becoming other of that which one held for one's own.

"[T]he more he or she learns to handle his or her experimental system, the more it plays out its own intrinsic capacities" writes Rheinberger (1997, p. 24), and explains this relation with reference to Lacan as an "intimate exteriority" or "extremity" of the thing, or as a relation with which the subject is "included in the inner exclusion of its object" (quoted from Rheinberger 2005, p. 53; also cf. p. 69).

Ludwik Fleck therefore speaks of the virtuosity guiding the handling of an experimental system as adeptness (1988/1930), whereby he is especially concerned with experimenter's acquired attentiveness for surprises and deviations, an expression which Rheinberger thus also translates (see Sect. 3.13) with the term "acquired intuition" (Rheinberger 2005, p. 62).

[98] Cf. Gamm 2000 and Hörning 2001.

3.11 Irony and Humour

If technology is understood as a medium in the manner described above, and references must be translated through nothing but media, then the dream (or nightmare) of a translation machine is also finished, and would be nothing better than a good joke: "déduit—amusement" (Serres 1992, p. 7). Just as a "universal language", such as Esperanto, could not overarch other foreign languages, but rather simply presents another foreign language, translations within an experimental system, and into an experimental system, can never be anything other than risky. But, just as the translation of a text from one language into another is both simultaneously risky, but not arbitrary, the step from one translation to the next, in a context moulded by technology, remains one that is risky, but not arbitrary, being rather guided by its intelligibility.

Intelligible, that is, for an appropriately trained, historically specific, and socially locatable, scientific community (Boyle's successors). The dynamics of science emerges not least from the fact that technology, as a black box,[99] does not need to be understood in its constancy by all those who use it, but rather only its use must be understood. It is firstly this possibility of the mobilisation of known knowledge, without having to actualise that knowledge (that is the technical experimental boundary condition), which creates the dynamising increase in complexity, leading to that which one today calls the "modern sciences".

The idea that we could undo the Babylonian confusion of languages with the help of technology is thus literally laughable.[100] Thus, contemporary translation machines repeatedly make us laugh by reminding us that translation cannot succeed through the mere application of rules, and can therefore never be completely technological.

Thus, Porombka also sees the failure of the attempts at building reliable translation machines as an unintentionally successful invention of a joke machine, which could serve as an amusing, and versatile, instrument in the production of the experi-

[99] Cf. Sect. 3.5 and for a closer reading of the concept of the black box with reference to dealing with technology cf. Latour 1999b, p. 183 ff.

[100] And actually, this must also be accepted by God. Dirk Vaihinger points out in this context God's surprising decision, in reaction to the building of the tower of Babel, not to destroy the tower—a reaction which would be understandable—but rather does way with the universal language, and condemns man to a never ending translation. ("And the Lord said, Behold, the people is one, and they have all one language; and this they begin to do: and now nothing will be restrained from them, which they have imagined to do." Gen 11:6). Since then, there are no longer any engineers who are not also bricoleurs. It was the seamless combination of technology and language as an instrument of science that threatened the godly autarchy: "The trick in God's punishment consisted of hindering the efficiency of a language of formulas and concepts as the cement and lubricant of a mythical or objective reason, which had become instrumentalised through its human appropriation." (Vaihinger 1999, p. 44, also cf. Derrida 1997) Since then, there have repeatedly been new ideas for developing translation machines, or the reintroduction of a universal language via a technological detour, or, as can be seen in the example of logical positivism, via a technologisation of language itself (on this cf. Porombka 1999); an attempt against which e.g. Peukert attempts to defend theology (cf. Peukert 1988/1976).

mentally[101] unexpected. Whoever, taking the translation of the sentence "the spirit is strong but the flesh is weak" from English into Russian and then translating it back into German, which means as much as "the alcohol is cheap, but the flesh is weak", and "recognises this in an undogmatic way as being correct", namely, as a beautiful surrealistic transformation, "knows that it cannot be about programming in a computer the image of man as the perfect translator." (Porombka 1999, p. 66).

The joke stems from the failure of the solemn efforts made carrying out translations using the application of a rule, its punch line gaining weight from the seriousness of a technology without humour. It may well be that this humour must become more sophisticated with the increasing sophistication of the translation machine, in order to be able to still perceive this difference in the future (for the jokes of contemporary translation machines are anything but subtle).

But almost certainly, as Stengers emphasises, every experimental work requires humour due to the absence of such a rule, and not the distance of irony. Stengers writes: "The ironic relativist ceaselessly repeats and celebrates the failure of the philosophies of the ground" (2000, p. 68). The position of the ironist is taken on board by the observers of science, "those who will not let themselves count, who will bring to light the claims of the sciences." (ibid., p. 66).

The ironist is, in this interpretation, the theoretician of the explorative crisis, the one who has taken his/her place on the sidelines of the event, and compensates this humiliation through the feeling of knowledgeable superiority over those who do not cease to seriously communicate in the world something about the world. Contrary to this, Stengers explains humour as "an art of immanence" (ibid.), and so, as an attitude which is characterised by taking on an impossible task, i.e. in the knowledge of the unavoidable risk, in falling short of the world, of being exposed, but nevertheless taking responsibility for its uncertifiable divisions by actively communicating.

The seriousness of the task does not thereby stand in opposition to humour, but rather forms its precondition. Taking the task, bound up with communication, so seriously that one cannot imagine oneself beyond it, and so beyond the shared [*geteilte*] world, forces strategies of immanence—and because these cannot take place in the form of a synthesis at a higher level because of the division [*Teilung*] of the world, the experimenter is left only the joke, the ruse, which must not even be particularly subtle.

The stupid British Navy, and the stubborn professor from Padua, Ares caught in bed with Aphrodite, the gods laughing all around them, the natural philosopher Hobbes, protector of a truth that no longer interests anyone, Odysseus's foolish opponent Cyclops, who calls out that no-one has injured him, and thus delivers an eternal model for the joke. They all stand there stupidly; all have become figures of fun, after they unintentionally fell into the trap of a ruse, irritated at a world no

[101] However, this cannot be unreservedly agreed with here: translation machines could, in the terminology chosen here, be understood as playful machines for the production of something new, but not as machines with which one can create something experimentally new—then their use does not here stand in the service of an attempt at opening communicative possibilities for an absent unknown.

longer functioning according to its familiar rules, a world that has rather become something other.

Ever since the explorative lost its claim to universality, and, with the experimental, a new form of world disclosure (while it has always been there) entered the world with a ruse; the universal explorers are the ones who have become, in this way, homeless. They are those who cannot stop striving for recognisable goals, and thereby miss that decisive something, because it is absent, and they do not want to take anything seriously that cannot be translated into an overarching rule.

However, whoever remains trapped in explorative thought, while, at the same time, as a theoretician of the crisis of the explorative, knows about the absence of such rules, because s/he is unable to greet the instability of communication with countenance, s/he takes nothing seriously,[102] and is thus also no longer capable of involuntary laughter. This is the laughter that is inevitably heard when the world has changed beneath one's very own hands, and one's own position is recognisably displaced.

Only ironic distance remains for these. The inclination of those on the margins of the event, who still like to draw a feeling of superiority from their position of powerlessness, from the fact that they know that theories are mere constructions of the world, that images are only images and not what is depicted,[103] that no knowledge is final and all knowledge generates new non-knowledge, that media form our view of the world, that "everyone views things differently" and so on. The ironic inclination thereby becomes recognisable as the habitual ethical attitude of the theoretician of the crisis of exploration, as an inclination to secure one's own sovereign superiority, or even oneself, in instability. Knowing about the shortcomings of the explorative does not place the ironist in a position of responsibility, for no-one is interested in what s/he has to communicate—in the world, it makes no difference.[104]

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[102] This also appears to me to be Bernard Stiegler's subject, in that he distinguishes "between those who care, and those who could not care a less." (Stiegler 2009b, p. 134), between those who are attentive and those who "pass the day with the attitude of 'what has it got to do with me?'" (ibid., p. 163).

[103] And so, inter alia, squander the chance of recognising the beauty of scientific images as images. When, for example, Thomas Ruff hangs C4-prints of constellations in a museum then this is not a commentary about the artificiality and designed nature of science, but rather that which it is: the presentation of constellations that have emerged in a scientific context (more precisely: in the European Southern Observatory), in an art context. Through this, neither science becomes art nor art science, but every attempt to distinguish them on the basis of a trivial concept of construction is carried out ad absurdum: in a reversal of the classical constructivist argumentation in the theory of science Ruff as artist says about these images which have been made in an observatory: "What happens in front of the camera is simply predefined. If one wished to intervene one would have to travel very far in order to make a change" (Ruff 2009).

[104] "We must be clear about the fact that all ethically oriented conduct may be guided by one of two fundamentally differing and irreconcilably opposed maxims: conduct can be oriented to an 'ethic of ultimate ends' or to an 'ethic of responsibility.' This is not to say that an ethic of ultimate ends is identical with irresponsibility, or that an ethic of responsibility is identical with unprincipled opportunism. Naturally nobody says that. However, there is an abysmal contrast between conduct that follows the maxim of an ethic of ultimate ends–that is, in religious terms, 'The Christian does rightly and leaves the results with the Lord'–and conduct that follows the maxim of an ethic of

If the division [*Teilung*] of a world stands at the beginning of every experimental work, which means the same as breaking with healthy commonsense, and the logic of the everyday (see Sect. 3.13), in order to follow a hunch that, initially, can neither be justified, nor sufficiently verbalised, then the insight for which the experiment aims cannot be separated from the risk of failure, and, above all, the risk of looking stupid. And if, finally, no experiment is possible, without one facing the impossible task of translation, then this presents a task that cannot be managed from the distance of irony.

If one cannot secure an escape route in sovereignty in the experiment, because everything depends upon bringing oneself to the limits of one's possibilities, then what is required is the event of the revealing humour of involuntary laughter that can bind together the ability to joke, to trick, with the willingness to fail, and a sense for the strength of the punch line which the seriousness of the task carries with it, to a shared world done justice to as shared.[105]

As such, humour can thus be seen as the ethics of responsibility which has become the habitus of the experimenter, as the correct countenance in the face of instability.[106]

3.12 Ingenuity and Virtuosity

What brings the experimenter closer to his/her aim is not, for a long time, nothing, and then a sudden insight, an abduction, or a brainwave, but rather a subtle narrowing of the area within which the experimenter suspects it is worthwhile to *grope* around in. This is an unbearable idea for those who hoped to find a radical difference (a systematic one, and not just a social, or gradual, one, or one formed through specialisation) between science and non-science, and based their hopes of enlightenment on the overcoming of naive, everyday understanding.

Thus, it was for Kant explicitly, the overcoming of groping around, and its replacement by reason, that distinguished the modern sciences from that which did not deserve to be called science. Whereby he reduced not only the praxis of science, but also the resourcefulness, the sensitivity and all that is vague in the process of insight to a moment of insight, and trimmed down the intimate interplay of things and the apparatus to a distanced question-answer-event, with the experiment as a mere means in the hand of the theoretician:

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responsibility, in which case one has to give an account of the foreseeable results of one's action." (Weber 1946).

[105] In the context of the critique of science cf. also Haraway 2000, p. 146 and p. 157.

[106] This should in no way imply that all experimenters have a sense of humour—not at all: as should have been made clear in Sect. 3.21 experimenters traditionally secure their sovereignty, as an alternative to ironic distance, in that they distance themselves from the experimental system imaginatively.

> When Galileo caused balls, the weights of which he had himself previously determined, to roll down an inclined plane; when Torricelli made the air carry a weight which he had calculated beforehand to be equal to that of a definite volume of water […]; a light broke upon all students of nature. They learned that reason has insight only into that which it produces after a plan of its own, and that it must not allow to be kept, as it were, in nature's leading-strings, but must itself show the way with principles of judgement based upon fixed laws, constraining nature to give answer to questions of reason's own determining. Accidental observations, made in obedience to no previously thought out plan, can never be made to yield a necessary law, which alone reason is concerned to discover. Reason, holding in one hand its principles, according to which alone concordant appearances can be admitted as equivalent to laws, *and in the other hand the experiment it has devised in conformity with these principles, must approach nature in order to be taught by it. It must not, however, do so in the character of a pupil who listens to everything that the teacher chooses to say, but of an appointed judge who compels the witnesses to answer questions he has himself formulated.* Even physics, therefore, owes the beneficent revolution in its point of view entirely to the happy thought, that while reason must seek in nature, not factiously ascribe to it, whatever as not being knowable through reason's own resources has to be learnt, if learnt at all, only form nature, it must adopt as its guide, in so seeking, that which it has itself put into nature. *It is thus that the study of nature has entered on the secure path of a science, after having for so many centuries been nothing but a process of merely random groping.* (Kant 1933/1787, pp. 20–21, my emphasis)

The experimental system is indeed the materialised setup of a question. But, it is not the materialisation of a question, previously posed in the mind of the theoretician. And, neither is it simply the materialisation of a written theory. The technological setup of the experimental system, in its exteriority is as little derived from speech and writing, as is writing from speech.

There is a tradition of experimental systems beyond scientific journals, and no experimenter can go behind its origins. When an experimenter has problems explaining exactly what it is that he is doing (just as anyone would have problems explaining what one has to do exactly when riding a bike to someone who doesn't know), then this does not mean that s/he is a bad experimenter—as Hobbes's heirs believe, as they cannot imagine that something other than the virtuosic command of language could be conducive to insight—it indicates only a problem of translation into another medium, a translation that might well be meaningless for the continuation of the experiment, because thought refers to the experimental system itself.

Now Boyle had himself, as an earlier experimenter, already set the foundation stone for misunderstanding experimental science as being secondary to theory, and in the service of a reason separated from the body. For, in order that the *result* of the *process* of knowledge acquisition can be appreciated as a factum of nature, it must be recognised as existing independently of its representatives, which is forgotten with the repudiation of the knowledge acquisition process.

Facts, however, are created with the appearance of technology in the experiment, which can in no way be observed independently of the technological-experimental setting. Already, Boyle himself could not show anyone the discovery of a vacuum beyond his own apparatus, just as Galileo could show no-one Saturn's rings without beforehand pressing his telescope into their hands.

Today we share [*teilen*] the world with things such as genes, which cannot be "observed" without a fully equipped laboratory, and, even with the help of a labora-

tory, they cannot be seen "as they are", but can only be disclosed through the traces of their existence. Boyle *compensated* this impossibility of direct evidence of an independent existence through the demonstrative distancing of self. He and his witnesses presented themselves, not only as being financially independent, and not at all present in the scientific text, but even in their bodily expression as being free from disturbing passions and feeling—and so the expression of non-involvement, despite involvement, came to inhabit the figure of the British gentleman (in direct opposition to the emotionally guided woman, and the financially dependent citizen).

If the motive for fraud was absent, and the non-involvement on the part of the independent side had been testified to, as one could describe it in the language of law, from which Boyle also borrowed his technology, then also absent was any occasion for doubt in the sincerity of the representatives of nature. The social setting of the experiment gave contemporaries schooled in the explorative acquisition of knowledge the chance to accept the fundamentally other, namely, experimentally won facts, as the truth. This was achieved by hiding the process and being able to present the result *ex post* as exploratively won (namely, observed from a distance, unprocessed, found and discovered, ahistorical, endlessly repeatable, represented in language, material, natural facts).

When the educational scientist Werner Kutschmann describes the history of modern science as an increasing disembodiment (1986), then he is correct, on the one hand, in something both true and crucial, namely the self portrayal of research as a process in which the body does not play a role. He thus, at the same time, misses the character of research through believing this, and also when he does not recognise what, for him, represents disembodiment, for what it is—namely, a bodily representation of disembodiment.

This could, however, be dismissed as a quibbling critique of Kutschmann, if it were not for the experiment in fact being characterised in comparison to exploration by an especially decisive inclusion of the body in the process of knowledge acquisition. Kutschmann appears, like so many authors, to view the world as influenced by an increasing tendency toward technologisation, and to think of dealing with technology in terms of dealing with an autonomously operating machine, in which the only interaction consists of pressing a button, and not about the dealings with technology which, in fact, characterise not only the everyday work in a laboratory, but also the everyday dealings with technology outside of the laboratory, dealings which are specifically characterised as being virtuoso performances.[107]

This virtuosity is won through familiarisation, practice, and a gradual cementing of the structures of expectation. It would be impossible to develop if the contact with technology were to be actually reduced to the moment of pressing a button, and not appear in the quantity, and the many forms, that it takes on everyday, and in

[107] On this cf. Steinle 2000, who refers to the restrictions in the executability of the experiment associated with this embodiment, in that "experimental experience is not *per se* independent of who, when, where, and under what conditions makes it" (p. 221), for they require *skills*: "while these were for some decades above all manual skills, they are more likely today to be special skills in computer programming or something similar. Such skills are available at certain times and places, but not in others." (Ibid., p. 219).

which technology is always only a part of the context referring beyond technology *and* the user.

In other words, virtuosity is the result of a successful embodiment. Whoever drives a car without thinking about every single movement is virtuosic in dealing with the car. That it no longer attracts attention does not reside in driving a car really being an intellectualised affair, in which the body is only there "in the shadows, on call" as a "head transporter" as Kutschmann writes, generalising about humans when dealing with technology (Kutschmann 1986, p. 411). It is rather that dealing with a car has, in the meantime, become so natural, and so widespread, that it no longer draws attention as to how virtuosic a performance it actually is.

This is true of the everyday use of a variety of technologies (as a sort of everyday freestyle), as well as dealing with technology in the laboratory. One can thus correctly say that it is wrong, but, at the same time, is an especially graphic example of the persistence of explorative thinking on into the late twentieth century when Kutschmann writes:

> The physical, 'aesthetic' as well as the operational powers of the scientist are completely irrelevant for grasping nature. The senses hardly play a role anymore in observation and experimentation; they have been relegated to the peripheral functions of recording data. The body as a whole, with all its imaginative and ideational powers, takes the part of a 'warden', who, silently and unobtrusively, without making a fuss about its own presence, only participates on the margins of the experimental event, and only in an emergency intervenes in a salvational manner. (Ibid., p. 409 f.)

If practical experimentation is thought, in a critical analysis such as this, to be secondary to an alleged "disembodiment of the sciences", so that one thinks that it has to be demanded that it be reinstated, in order to free it from its thankless role as a "head transporter", then it becomes understandable how one could arrive at the idea of searching for the cause of scientific innovation literally in the heads of leading scientists.

What Michael Hagner sketches, from the eighteenth century until now, in the *History of Elite Brain Research*, that appears so bizarre, i.e. using instruments to search around in the heads of dead geniuses for the reasons for their genius, appears logically consistent with the background of thinking science from the basis of theory. If the moment of innovation is located, not in the dealings with things, but rather in the "brainwave", which takes place exclusively in the development of theory, as opposed to an experimental praxis, then it is barely unavoidable to look for those causes in the head.

If the processes in the experiment adjacent to the observer have grown so much in significance that they can no longer be solely related to preparative tasks, or methodological setups, secondary to the knowledge acquisition process, but have rather become so much a part of that process that Rheinberger can speak of the experimenters as thinking with their hands (Rheinberger 2005, p. 62), and Leroi-Gourhan can say that those who no longer prefer to think with their hands had lost a part of their normal and phylogenetic human thought (Leroi-Gourhan 1993/1964, p. 403), then it is not just the theoretically explicit components of knowledge at work in the knowledge acquisition processes but also, perhaps above all, the com-

ponents of knowledge sedimented in the body of the experimenter, via the handling of the technology, his/her apparatus, and the whole experimental setup.

Thus, Pawlow's *practicants* had to learn to deal with their dogs, and the dogs had to learn to deal with their *practicants*[108] in such a way that they can react to one another without having to think about it (cf. Todes 2004). And, the researchers of the zones on the margins of the rain forest observed by Latour had to develop a feel for the sandiness of the earth in the tips of their fingers (Latour 1999b, pp. 24–79), just as every experimenter has to develop a feeling for the fine tuning of an experimental system (Pickering 1995 and also see 3.14).

If one is interested in the *process* of experimental knowledge acquisition, and that means being interested in the question as to how one feels one's way toward something by groping around, when one does not even know what it is, or even how it might show itself,[109] then one can as little ignore this corporeal aspect of research as one could ignore the non-explicable involvement of the body in other complex interactions. One might, out of explorative interest in the explorative, go on searching for the genius of scientists in their brains; from the experimental perspective, however, it is much more interesting investigating the question as to how one acquires virtuosity in dealing with things.

If the body is, in this way, drawn into the knowledge acquisition process itself (while it is almost ironic to see that, today, it is precisely the recording of data that can be delegated to the computer), and the abilities of the body are epistemologically used to sediment simultaneous and complex interactive processes in the form of embodied expectations, just as when one, in driving a car, by practicing, soon arrives at the point where the foot is already on the brake before one consciously realises that something is running across the road, then it is these bodily expressions that one must hold onto if one wishes to know where the *deviations* arising from such sedimented expectations register.

Because an experimental system is not a machine, it also cannot produce insight alone. An experimental system needs the trained experimenter: "[T]he more he or she learns to handle his or her own experimental system, the more it plays out its own intrinsic capacities" (Rheinberger 2001, p. 18). The nose that an experimenter needs, to be able to find the traces of the unknown, must be developed through

[108] Because of their ability to communicate they are not simply damned to passively being-described. If already the focussed association of Pawlow's practicants with their dogs can only be understood as a one sided description by blending out all the evidence, then this is even more so with the everyday handling of dogs. If dogs in particular offer themselves as an example then it is because of their pronounced ability to influence social structures, and to orientate their communication even on the involuntary communication of humans; this is not a metaphor, these dogs understand our communication sometimes better than we theirs—and, as has been proved, in part better than we understand ours: cf. the example of the faked yawn: Joly-Mascheroni et al. 2008. That Haraway is interested from a scientific perspective in dogs is therefore only a consequence in the sense of a "symmetrical anthropology". Cf. Haraway 2008 and 2003.

[109] Also cf. Stiegler, who describes his technological-philosophical approach in such a manner that one could translate it as groping or feeling: "The work presented here is nothing but a tentative approach to these questions, as subject to trial and error as it is resolute—advancing by trial and error (with the hand permitting) is the very object of this reflection." (Stiegler 1998, p. 1).

handling the experimental system itself. Because the experimenter does not know what s/he is looking for s/he must rely on his/her intuition—intuition that a layman does not have.

The experimenter *cherishes* his/her intuitions; s/he cares for them and develops them, by protecting them from the chaos of the world, using the world dividing [*teilenden*] boundaries of an experimental system.[110] When Fleck describes how experimenters unthinkingly find the trail, he does not distinguish between the apparent alternative between targeted striving and more arbitrary discovery,[111] but rather speaks of expertise, of that which Rheinberger terms "acquired intuition."

Only in the explorative understanding of the experiment, in which one merely observes, and can satisfy oneself with using the experimental apparatus only once, understood as it is as a tool for the purposes of falsification, developed according to the ideas of the theoretician, does intuition not need to be accounted for. The feeling of the experimenter that s/he is on the right track if s/he continues to research in this or that particular direction is naturally not knowledge.

However, if one understands intuition, not as something pre-existent, but as something acquired in Fleck's sense, then it is still not yet something rational, but also not something irrational, that one must ignore in the service of the truth. On the contrary: if it concerns experimentation, one may not ignore intuition. And its epistemological role and meaning becomes especially clear when one compares it with its explorative counterpart, which one finds in intention.

3.13 Intention and Intuition

When intuition is being spoken about, of the "power of intuition" or even "gut feelings", then, as a rule, one knows straightaway: that has nothing to do with science. The feeling that one should keep well away from these concepts, which so reliably demonstrate bad intellectual taste, could suffice as an initial indication of the workings of intuition. If it specifically concerns that intuition which says that the use of this word normally follows an uncomfortable mix of anti-intellectualism and affirmation, then one is not only mostly right, in this case, its detractors gladly rely upon it.

If one, for example, is dealing with an overwhelming complexity, such as is the case with the mass of reading material in the science business, then ignoring publications is unavoidable for reasons that are *not* based on the complete consideration of all objections and arguments—if only because one would have had to have read

[110] This double meaning can be etymologically found in the word hegen (to tend, to care for): "hegen swV. (<ninth century) Mhd hegen, ahd. In *umhegen* 'to fence in' Factitivium to Hag (hedge), therefore initially 'to surround with a hedge, to fence in' and then developed to 'to care for, to keep'. Accordingly, ae *hegian* 'to fence in.' Abstract: *Hege* (game keeping)." (Kluge).

[111] One could say with François Jullien that it concerns an alternative to the thought of the "path", and from letting oneself be carried by something supporting (2004).

what one wished to ignore. This paradox (one must know, what one ignores) is not solved in the praxis of science (which naturally also includes the praxis of the development of theory), by oscillating between subjectivism (one only reads what one likes) and accident (one reads what falls into one hands), but rather through an *acquired sense* for what is worth reading, and what not, which is never theoretically complete.

Whoever believes that this is simply a pragmatic problem, that can be ignored when attempting to understand the processes of knowledge acquisition, that it is thus epistemologically irrelevant or, if one will, a mere supplementary problem, misjudges not only the difference between scientific theory and scientific praxis, but also the division [*Teilung*] of the world accompanying every science. For, the fact that no knowledge process has ever attached itself to the quasi-transcendental distinction between the disclosed and the undisclosed of the world, but rather always only through a Re-Entry on one of the two sides of this distinction, also means that every science always stands in contact with that which can never be totally scientific, without it thus becoming irrational, or even mystic.

What is valid for the praxis of pure text based theory is especially valid for the praxis of natural scientific experiments (which, as an aside, does not present such a clear cut confrontation: see Sects. 3.14 and 4.7), insofar as every experiment has to begin with the reduction of an overwhelming complexity of the world.

In order to theoretically locate this way of overcoming complexity as an unavoidable element of every experimental opening up of the world, and to gain an idea of what orientates the course of an experiment, and thus removes it from the pure effect of contingency (without being able to thus prevent its failure), the rehabilitation of the concept of intuition is essential, abused as it is up to the limits of its usefulness. This is yet more bad news for those who are interested in a foundation of the sciences, or the discovery of a clear boundary between science and non-science: now, even intuition should no longer be excluded from rationality.

I have adopted the idea of the concept of intuition from Rheinberger, and translated it into the context of the experimental thought system; Rheinberger has adopted the concept of expertise from Fleck, and translated it into the context of the history of the synthesis of protein in the test tube. Fleck speaks of expertise, Rheinberger of "acquired intuition": "Experience is an intellectual achievement. Expertise, that means acquired intuition, is a form of living and working. The expression 'acquired intuition' poses a contradiction in terms. Expertise *must* be learnt, that lies in the nature of the thing, but it still at the same time exceeds what *can* be learnt in an explicit sense." (Rheinberger 2005, p. 62)

In the experiments of natural science it cannot be learnt exclusively through talking and listening, reading and writing, but must rather be learnt by handling the apparatus (cf. Fleck's discussions of text books and introductions to the Wassermann reaction, especially 1980/1933, p. 72 ff.). Stichweh puts it similarly when he writes that it is no longer sufficient "to describe an experimental system as *a complex configuration of instruments*" (1994, p. 192, emphasis in the orig.). Rather, it is necessary to also think that these "scientific methods and further informal and implicit ways of knowing ('tacit knowledge', 'know-how')" would be included (ibid.).

According to Fleck, learning to deal with an experimental facility always accompanies the introduction into a certain "style of thinking" (Fleck), which is why one cannot understand the apparatus in isolation from its use in a defined theoretical-historical community of thought:

> All experimental researchers know how little a single experiment proves and induces: a whole system of experiments and controls always belongs to it, a prerequisite (a style) accordingly assembled and executed by an expert. It is just these prerequisites and the praxis, both manually and mentally, which, together with the whole experimental and non-experimental, with both the clearly grasped as well as the unclear 'instinctual' stock of a researcher's knowledge, forms what we wish to term expertise. (Fleck 1980, p. 126)

This expertise, or "acquired intuition", falls from sight when one exclusively relies upon the written in researching scientific praxis (which is why it is already explicable for methodological reasons that Popper can ignore the idea that the handling of the technology itself can have an effect on insight in experimentation): "The summarised report about an area that has been treated always contains only a very small part of the researcher's pertinent experience and that is not the most important, i.e. not that which makes possible the perception of form according to the appropriate style. It is as if only the text of a song has been given, but not the melody", writes Fleck (ibid.).

Intention is bound to concrete aims; intuition is based upon complex arrangements that are not intentionally resolvable. One and the same state of affairs can be considered from the perspective of both the intentional as well as of the intuitive moment. Wanting to drive with the car from A to B is intentional, with the car being a means to an end. The interaction of changing gears, indicating, keeping an eye on the street, and the instruments, listening to the sound of the engine, and feeling the road surface as a running corrective, in short, the whole complex interaction of driving *with* a car itself, is predominantly an intuitively managed process. It cannot be meaningfully grasped with "intention" alone, and must be accordingly otherwise described.

If one is concerned with this interaction, then it is impossible to divide it into intentioned single movements (because a complex process is involved, thus one in which things simultaneously happen, and so occur non-causally, it really is an impossibility, and not just an impracticality). It would be just as meaningless (and these are necessarily bound up with one another), to describe the individual parts of the car, each as a respective means to an end. Not even the separation of car and human would be a meaningful starting point for such an intensive description of driving.[112]

Virtuosity in handling a car is learnt, and embodied, *through handling* the car; handling the car is not an application of that which is to be found in the handbook, and neither is it to be acquired by thoroughly studying it. The handling of technol-

[112] This is also what concerns Latour and the actor-network-theory. Their boundaries are constituted through the absence of a distinction between a comparable experimental and explorative distinction and, associated with this, the will to understand this kind of example as a universal representative for dealing with things.

ogy in an experiment, with the aim of gaining insight, accordingly constitutes a similar behaviour: one actually thinks with the technology, whereby it can only be described as a means to an end, under a miscomprehension of all that which is important in the knowledge acquisition process.

If the other [*das Fremde*] concerned is absent, and thus the goal of an explorative approach which would be graspable as a described discovery is also absent, then the experimenter, instead of having it available, must feel the way to his/her goal, and the focus of meaning shifts from intention to intuition. In the scientific everyday, one naturally knows that one cannot strive for research results in the same way one drives a car to its destination. For this reason, a kind of tongue in cheek handling of project plans has developed, which can still be put together with defined ideas of timings and goals, but in the full awareness that these will have to be revised at least once, or even several times.

This *ironic* (see above) behaviour is, however, not explicated in the sense of experimental work, but is rather first of all just another symptom of the persistence of explorative ideas, insofar as the *revision of goals and timings is actually believed*, and an explorative understanding thus maintained. Intuitively suspecting that there is *something* there, is completely different from replacing the concrete goal x with the concrete goal y. In the first case, one finds oneself in a process of defining goals, while the latter describes the transition point between two concrete goals.

However, as long as intuition is firmly identified with the "common sense" of the layman, and his/her thoughtless domination of the everyday, and (as mystical "gut feeling") opposed to rationality, reflection, and the break with the everyday understanding exhibited by experts, professionals or theoreticians, then the meaning of intuition for expert praxis, especially when it concerns the praxis of theoretical work, cannot be seen, but only repressed. But, in light of the division [*Teilung*] of the world, brought about by the constitution of an experimental system, and through the translation which, due to the iterative event, is necessarily time based, and leads to the acquisition of experience, intuition can, on the contrary, be thought of as both acquired and as the result of a decisive break with the "common sense" of the layman, and his/her thoughtless domination of the everyday.

Along with the crisis of explorative thought as a consequence of the increasing closure of the world, and the discovery, at first restricted to language, that this could no longer be thought of as a means to an end of the intentional speech of a sovereign subject, standing in the middle of events, everything became a problem. The sovereign subject, the function of language, as well as the intentionality which should all be found at the centre of events, but now have to be iteratively thought as a temporal event, proved themselves to be absent. In a discussion of Austin, Derrida writes:

> given this structure of iteration, the intention which animates utterance will never be completely present in itself and its content. The iteration which structures it a priori introduces an essential dehiscence and demarcation. […] Especially since this essential absence of intention for the actuality of the statement, this structural unconsciousness if you will, prohibits every saturation of a context. For a context to be exhaustively determinable, in the sense demanded by Austin, it at least would be necessary for the consciousness intention to be totally present and actually transparent for itself and others, since it is a determining focal point of the context. (Derrida 1982, pp. 326–327)

If the focus is now on intuition, then not in order to reoccupy the place held by intention within this system of context and speech (of sovereign subjects and means to an end, pure medium and so on, in fact, all that which together makes up what is here termed the explorative system of thought). The concept of intuition being here approached would be unthinkable in the explorative system of thought.[113]

Neither does it concern the negative proof that intention is not able to: "govern the entire scene and the entire system of utterances" (Derrida 1982, p. 326). It does, however, concern an affirmative answer to the question as to what could be a guiding element in the experimental process of knowledge acquisition. This is characterised by the strategic exploitation of iterability, and the difficulties concerned with creating the possibility for something that is absent to break out of the ideality of repetition in a manner which is recognisable to the experimenter, something which intentionality is evidentially not able to do.

Intuition, as it is understood here, only gains in significance in association with the experimental system of thought. And thus, one can say that the attempt is here being made to contribute to the project to find a new form of description for other types of iteration using the concept of intuition being put forward, in the way that Derrida perhaps means when (with reference to Austin) he writes:

> Thus, one must less oppose citation or iteration to the noniteration of an event, than construct a differential typology of forms of iteration, supposing that this is a tenable project that can give rise to an exhaustive program, a question I am holding off on here. In this typology, the category of intention will not disappear; it will have its place, but from this place it will no longer be able to govern the entire scene and the entire system of utterances. (Derrida 1982, p. 326)

If one translates this into the situation of the experimental system then the difference to the classical idea of the experiment becomes clearer: if one understands the experiment as an iterative approach, then that which the experiment deals with can never be exact and controlled, nor can it be a means to an ends, for the purpose of falsification. The aim of the experimenter consists much more in creating a structure which evades his/her own intention, a structure in which the experimenter decentres him/herself (cf. end of Sect. 3.7).

This is only possible within, and through, a technologically supported exteriorisation, and by ascertaining, via an appropriate technological effort, that this technology never becomes totally "technological." For, the experimental system is not a machine, just as the car with the driver behind its wheel, in silent interaction with other road users, deer running across the road, and a jungle of road signs, cannot be meaningfully and sufficiently described as a machine.

For, finally, it is not a matter of more contingency; it does not mean putting oneself in some such context which one cannot govern—very little would be achieved

[113] Of course, there is *a* concept of intuition in explorative thought—but it means nothing other than the unbroken everyday meaning, it means feeling as opposed to intellect; one listens to one's "gut feeling" instead of one's "understanding". Intuition is, in this sense, a deeply anti-intellectual concept, and is incompatible with the aim of understanding technologically mediated knowledge acquisition processes being followed here.

if a layman sat in a biology laboratory just because one believed, because of a critical stance towards intention, that it would be enough not to be able to intentionally manage a particular situation. One must be able *to think* within one's experimental system.

Naturally, Watson and Crick did not know that they would discover the structure of DNA, and so could not plan for it, but they had an idea that they were on the trail of something. That their story is nevertheless so easily reduced to the brilliant idea of the double helix can also be certainly explained by the fact that almost all the preparative work had already been accomplished by others. It is, however, not useful wanting to reduce knowledge acquisition processes to the moment where everything that has been gathered and translated forms a picture in someone's head, just as it is meaningless trying to understand the development of a software system through a close consideration of the moment of its compilation.

An acquired intuition, therefore, guides a goal oriented process in which the goal is absent. Thus intuition is, in this context, with reference to the whole experimental process, a name for that, at the beginning *and* end of which, the *ability to be attentive* to the indications of the absent unknown stands—an attentiveness which must be both presupposed, as well as having to be learnt, and is trained and altered in this intuitive and non-intentionally oriented process.

It is not the will to reach a definitive, and definable, goal that characterises the experimenter, but rather the ability to train one's attentiveness for the deviations in an iterative process, and for something which is to be found on the borders of experience, consciousness, and attention, as Waldenfels writes (2004, p. 172). Thus, one never stands at the beginning, but is always already in the middle (cf. Haraway 1995, pp. 98–122). Without having a vague idea that something is absent, there would be nothing beyond the application of techniques and methods, except trial and error, and mysterious abduction.[114] It is intuition that determines those "free and fluctuating times", of which Serres says that there is nothing which is more difficult to have an idea of, "which is not yet completely determined, in which the researchers in their investigation basically do not yet know what they are looking for, while they unknowingly already know it" (Serres 1994, p. 17).

Intuition thus has nothing to do with "feelings", as opposed to rationality, and it is also not something that one has. On the contrary, intuition, as it is understood here,—and this is backed up by experience in the laboratory—is highly demanding, and is to be understood as the result of an intimate interaction with an experimental system. It is in no way something the origins of which are to be meaningfully

[114] Which would lead straight back to the paradox described as classical by Plato from the Meno dialogue: Meno: "And how will you enquire, Socrates, into that which you do not know? What will you put forth as the subject of enquiry? And if you find what you want, how will you ever know that this is the thing which you did not know?" and Socrates answers: "I know, Meno, what you mean; but just see what a tiresome dispute you are introducing. You argue that a man cannot enquire either about that which he knows, or about that which he does not know; for if he knows, he has no need to enquire; and if not, he cannot; for he does not know the very subject about which he is to enquire" (Meno 80d-e).

located *in* the subject itself. Theodor Litt expresses this surprisingly concisely when he writes:

> Nothing in the least is taken away from the significance of the method by an experience to which one not seldom refers to in order to depreciate its participation in the work of insight. One remembers the lightening strike of illuminations which have led some researchers to previously long and vainly sought solutions to problems and, on the basis of this, think that 'intuition' should be played off against method. This can be countered by the fact that the researcher would never ever have an intuition in which the solution to a problem he is dealing with would show itself, if he had not beforehand wrestled for the solution to this problem with methodologically disciplined thought. (Litt 1959, p. 57)[115]

Insofar as intuition represents something acquired, and is oriented towards deviation from order, in its interaction with the experimental system, then it can be equivocated with what Waldenfels terms "embodied attention": "Attention, as an intermediate event, which can neither be based on *something* that attracts our attention, nor on *someone* who notices, that thus finds a sufficient ground neither in objective facts, nor in subjective acts, is and remains dependent upon intermediate states that make experience possible." (Waldenfels 2004, p. 137) And, just for the sake of comprehensiveness, because this idea also exists: it is of little meaning accounting for intuition as an automatic processing of decisions which is contrasted with the absolute self-certainty of the subject (e.g. Glöckner 2006, p. 32 ff. and 271 f.).

There are still attempts to think of the experiment exploratively because the explorative view of science is still dominant, and so the procedural, the training of experience, falls from view. Fleck brings this state of affairs to a head when he distinguishes, in his words, between observation and experiment—a distinction which can now be generally assigned to the distinction between exploration and experiment:

> There is a very common myth regarding observation and experiment. The knowing subject figures as a manner of conqueror of the type Julius Caesar, who wins his battles according to the formula veni-vidi-vici. One wishes to know something, one makes an observation or an experiment—and already one knows it. Even researchers who have won a few battles believe this fairy tale when they consider their work retrospectively. At the most it will be admitted that the initial observations might have eventually been imprecise, while the second or third had already been 'adjusted to the facts'. (Fleck 1980, p. 111)

Wassermann, whose investigations of syphilis Fleck here introduces as an example, could not have known during his attempts at what his experiment was aimed at (the goal was absent). Not once were the intermediary results clear (intermediate goals were also absent): "It is therefore clear that the deviations in the experiments were not in focus, that some experiments delivered distorted results, that often one had to decide whether one could speak of a positive or negative result of an experiment." (Ibid., p. 113).

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[115] Even in the texts which understand the experiment as an instrument of falsification, hints of the necessity of the acquisition of intuition creep in: so, for example, in Wilfried Kuhn, who examines the role of intuition using the example of the "Discovery of the Wave Nature of Material", although he still must dialectically speak of an "interplay between theory and experiment in the discovery of the wave nature of material" as he essentially opposes experiment to theory. (1988, p. 43 f.).

However, this is, for Fleck, anything but a blind testing around. Wassermann was so familiar with his experimental system that he could think within it, without being able to control it (instead of controlling it and thinking *with* it). Fleck makes use of a metaphor to describe that which is neither an intentional procedure, and thus merely using the apparatus, nor blind trial and error:

> It is also clear that Wassermann heard a melody which hummed within him coming out of those confused tones which, for those not involved, could not be heard. He and his colleagues listened and tuned their apparatus for so long, until it became selective, and the melody could also be heard by those (unprejudiced) bystanders. The community of those who rendered the melody audible, and its listeners, steadily grew. It is not fitting to speak of the correctness or incorrectness of the initial attempts as something very correct was developed directly from them, without being able to term them [the initial attempts—trans.] correct. (Ibid., p. 114)

Describing the formation of an insight as a melody is a metaphor; to write that experimenters think *in* their apparatus is not a metaphor, but rather a precise description, with the correspondingly precise description of explorative thinking *with* the apparatus as its counterpart.

"Expertise", Rheinberger writes in explaining Fleck's expression, makes it possible to "embody estimates and judgements in the process of knowledge acquisition in a certain way, that is, thinking with tools and with hands." (Rheinberger 2005, p. 62) This is a totally different perspective on the role of expertise in the experiment from that found, for example, in Lehmann-Rommel's interpretation of Dewey, which does not think of "expertise" as the prerequisite for experimentally thinking something otherwise, but rather as a "trap of the familiar". This should be avoided in order to "consider automatic conclusions and contextual expectations as hypothetical and to proof them as such" (Lehmann-Rommel 2008, p. 122).

Because Lehmann-Rommel holds onto Dewey's distinction between "technical experimentation" and "experimental thought", does not question the primacy of the visual and, on top of that (and related to it), does not see the position of the experimenter at the centre of events as being in doubt, then the possibility of the new can only be recognised from afar, through a reflection of thought *on itself*, and not in the heightening of attention towards that which is being experimented with, nor can that which is being experimented with be technology in their eyes (it is rather only "thought").

For Dewey, the way to escape the "old rails" (ibid., p. 129) is not presented by the attentiveness for that which, in the experimental system, is pushed out of the ideality of repetition with the help of the technology involved. It is thus not the attentiveness for something of which one cannot yet say what it is, except that it is probably *something*[116]—an attentiveness which one first gains after one has intimately familiarised oneself with the experimental system, so that the experiences there have been sedimented into one's body[117] as expertise, and can there become

[116] Cf. Waldenfels 2004, esp. pp. 162–185 on the resourcefulness of the body in technology.

[117] On the whole, one could also relate this discussion of the concept of intuition to the discussion regarding the "return of the body" (cf. Kamper and Wulf 1982). As an alternative, also cf. the

an effective guide for one's attentiveness. It is rather, in addition to the distance to technology, "*the observation of our activities* e.g. talking and writing" […] as the condition of gaining *intentional influence in the automated ways of perception and acting*." (Ibid., p. 128, my emphasis) More observation, the reinforcement of intentionality, and concentrating on oneself, are therefore the conditions for seeing something experimentally new.

Consequently, *only* the great "extent of the identification with one's own ego with the familiar paths of thinking, feeling and acting" (ibid., p. 129) presents an obstacle for experimental thought. If that were true, then the problem would not be the problem of the unknown in its absence, but rather, solely, a problem of the self with itself. And, the criteria for successful experimental thought—namely, creating the possibility of communication for something unknown, or at least keeping a place free for its absence (i.e., attempting to do justice to the shared [*geteilten*] world as shared [*geteilten*])—would be lost.

Lehmann-Rommel writes that the "central revolutionary characteristic of experimental thought in Dewey says that nothing is fixed in an experimental operation—neither the guiding ideas, conclusions and judgements, nor the observed or the presumed nature of the object" and it can fall back upon "no authority from past insights without proof" (ibid., p. 130).

This would, indeed, be a revolution, for that is, in fact, impossible. Probably what is meant, however, is that there should be nothing that, *in principle*, thus, in a quasi-transcendental sense, may be put forward as being fixed. This is, however, not information (rather just a *confirmation*), for, the work on the boundaries of the disclosed and the undisclosed does not take place directly, but only through the Re-Entry of the same distinction, processed on the side of disclosedness.

Lehmann-Rommel de-historicises the experiment when she writes that it was a good idea of Dewey's to claim that "nothing is fixed" and "no authority from past insights" would be taken onboard unproved. For, what counts in the experiment (see also Sect. 3.1), is precisely the opposite: in experimenting, almost everything that has been gathered from previous insights is fixed, right up to the limits of perfection.[118] For, it is only against this technologically fixed background that what beforehand was swallowed in the roar of the world can begin to show itself.

Waldenfels similarly describes this with reference to the relation between order and otherness [*Fremden*]: "at the boundaries of every order the unknown appears in the form of the extraordinary, that finds no place in the respective order, but is not, as excluded, nothing. In that it is not absolutely excluded, but rather from a particular order, means more than the grey in grey of simple indeterminacy" (Waldenfels 2006, p. 9).

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thematically appropriate Kutschmann 1986; cf. the theoretically more appropriate Butler 2011; on the rediscovery of the body completely turned to signs by consumerism cf. Baudrillard 1981/1970; for an overview cf. Csordas 1996.

[118] In fact, the majority of natural scientific experimental work consists quite literally of fixing: cf. Rheinberger 2006b. pp. 336–349.

Zamecnik too, whose work on the synthesis of protein in the test tube is comprehensively described by Rheinberger, "had a feeling for how much identity, stability, operational definition, and cooperation, a system needs in order to serve as a basis for the production of non-anticipatable events" (Rheinberger 2001, p. 50), which, "without a system of sufficiently stable identity conditions, the differential character of scientific objects would remain meaningless; they would not possess the characteristics of epistemic objects, but would become arbitrary and diffuse." (Ibid.) Of course, none of this may exceed the limits of perfection, and fall into the machinelike:

> Scientists are, above all, 'tinkerers', bricoleurs, rather than engineers. In its non-technological character, the experimental ensemble transcends the identity conditions of the technical objects which hold it together. For, on the side of technology we find a similar principle. Tools being currently used can take on new functions within the process of their reproduction. If they fall into contexts which exceed their original purpose then properties can become visible which were not intended in their design. (Ibid., p. 30)

A quick look back at Boyle: now, one can also see why it is today no longer necessary to exclude women and the non-gentry from science—the scientific community has autonomised itself, according to its own measure, to such an extent, that the social differences between speaking witnesses and mere blabbing onlookers has been internally renewed through carrying out science. Fleck observed that even experienced scientists at first found it difficult to recognise the connection between the results of the Wassermann reaction and syphilis: "Such expertise, which only slowly becomes generalised and has to be continually re-acquired by practically every adept, creates that which the first critics of the Wassermann reaction were missing." (Fleck 1980/1933, p. 126)

They could not see what the others saw. So it was with Hobbes, as well. Of course he saw that the bird was dead after Boyle had fiddled around with his pump. However, he did not see an asphyxiated bird, but rather, a sensitive creature, whose heart stopped because of the violent motion in the ether winds, caused by the movements of the pump (Fink and Weiss 2001, p. 3 f.).[119]

If one understands intuition in this sense, not simply as guiding, but also, to the same degree, as a consequence, as an expertise sedimented in the body, then it also becomes clear that acquiring such an intuition, which could lead to the new, can only succeed through a break with that intuition.

On the one hand, the path to the new runs directly *via* intuition as that which gives direction to a targeted process without an aim, as the only possibility of gaining distance to intention and, instead of *steering toward* an aim, to *investigate* something that is not even determinable as being indeterminate.

On the other hand, such an intuition, which places one in the position of being able to arrive at something new, can *only* be acquired through *breaking with the continuity between intuition and the conditions under which it is acquired* (e.g. in that one resolves to acquire certain abilities).

An intuition acquired in everyday life lets one get through the day as if sleepwalking, but it cannot lead to one perceiving everyday life from a totally different

[119] On "learning to see" also cf. the comprehensive Daston and Galison 2007.

perspective. This forms the basis of the justified scepticism against intuition as the height of critical incompetence (and it explains the attraction of this concept for those who long for a harmonious union of the self with the world).

An intuition acquired in science can make one a good normal scientist (in Kuhn's sense), able to bring something new into the world—intuition enables the scientist to perceive the world beyond its everydayness, due to a preceding break with the world. But, only a break with scientific everyday life enables the scientist to arrive at something new *in* this science. Independent thought is a task, not a precondition.[120]

It was, in Rheinberger's account, only possible for Zamecnik to arrive at something decisively new because he put together a team of scientists who were able to fall back on the most varied of experiences, and who had not acquired their intuition directly from the field in which they were researching (but had sufficient experience within this field to be able to handle its apparatus and talk with colleagues).

This also makes clear why scientific processes of innovation are not equivalent to processes of *Bildung*. Whoever does "normal science" might well bring the world something new, but remains within the continuum of experience and intuition, and in no place breaks with his/her own "relation to world and self". S/he concentrates, as Kuhn writes, on such "problems […] only their own lack of ingenuity should keep them from solving" (Kuhn 1975/1962, p. 37).

Only innovation within science lets itself be simultaneously understood as a process of *Bildung*, as it is based upon a break with the continuity of science, and necessarily comes with a fundamental transformation of one's own "relation to world and self".

Seen biographically, the latter almost inevitably means a risk in that one not only leaves the field in which one has learnt to move with the certainty of a sleep-walker, but also dedicates oneself to problems the overcoming of which requires more than just acumen. It requires, for example, that one intellectually moves beyond that which for colleagues remains intuitively comprehensible, whereby one inevitably finds oneself at a loss to explain, and does not oneself *know* where things are actually leading to, or what one is actually doing.[121]

In the explorative approach intention is primary (which does not mean that there is *only* intentional action—that is already, for reasons of complexity, utterly impossible), while experimental action is characterised by intuition being primary (which equally does not mean that there is *only* intuitive action). Intuitively, Zamecnik assumed that one would not get any further if one continued going on as before, and, as a consequence, *purposely* chose colleagues from other areas. These were also able to make changes to the technical apparatus. One could say, with Bourdieu that, apart from the hysteresis of the habitus, the hysteresis of the habitat must also be considered.[122]

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[120] On this, also cf. Bohrer 2007.

[121] Whereby it becomes at the same time clear how one can hinder initial insight: through narrow evaluation.

[122] A project that Bourdieu has not seriously followed. For an initial approach cf. Bourdieu 1997.

It cannot be a coincidence that an author such as Lyotard, who thinks the problem of the unknown on the basis of its absence, and makes that of language,—instead of understanding it as an instrument with which one could, in principle, say everything in a space, open in principle—in its tendency towards discursive closure, to his underlying problem, points out that one cannot say everything that has to be said with language. And further, it cannot be a coincidence that he places a feeling which cannot be more closely specified, at the centre of his arguments, a feeling about *something* that indicates the necessity of giving something the possibility of communicating:

> The differend is the unstable state and instant of language wherein something which must be able to be put into phrases cannot yet be. This state includes silence, which is a negative phrase, but it also calls upon phrases which are in principle possible. This state is signaled by what one ordinarily calls a feeling. (Lyotard 1988, p. 13)

And, with reference to the example chosen by him in *The Differend: Phrases in Dispute*, regarding the silence of the victims of Auschwitz, he writes: "This feeling is not based on the provable experience of a subject. It can, indeed, never be proven. Anyhow, how would one be able to determine whether or not it existed? One meets difficulties that are thrown up by the idiolects. The silence that the phrase *Auschwitz was an extermination camp* encapsulates is not a state of mind, but rather a sign that something unexpressed, undetermined, remains to be expressed." (Ibid., p. 106)

This feeling is anything other than a simple analytical category without an empirical claim. It gives the efforts at creating possibilities for this something, which itself does not present a definable goal, a direction—and thereby a decisively ethical dimension. In his account of the central significance of this "feeling" for Lyotard, Koller emphasises that it thereby concerns two aspects.

On the one hand, an opposing concept to a "view which understands the speech act as an exchange of messages, and communication partners (subjects), together with their messages (intentions), as positioned antecedent to their respective linguistic setting." (Koller 2000, p. 306) On the other hand, a delimitation against a kind of linguistic fundamentalism, that is basically nothing other than a type of positivism with inversed signs.

Accordingly, Koller also defends Lyotard against similarly motivated interpretations, such as, for example, by Wolfgang Welsch: "Lyotard does not directly reduce everything to language; he much more insists upon a 'beyond' language, which only registers as a 'feeling'." (Ibid., p. 314; fn 8)

Thus, it seems clear that this "feeling" in Lyotard, the "being able to listen", or "expertise", in Fleck, or the "acquired intuition", in Rheinberger (all these concepts and descriptions having different meanings in their respectively differing theoretical contexts, yet each arrives at a comparable strategic location in their respective delimitation to intention, insofar as they all refer to an absence), respectively indicate the total distinction between two impossible idealities. In the context of experimental science, Rheinberger describes this something as the epistemic object: "epistemic objects embody, paradoxically stated, that which one does not yet know. They have the precarious status of being absent in their experimental presence; but they are not simply hidden, to be brought to light by clever manipulation." (Rhein-

berger 2001, p. 25) They are the absent unknown that, in its absence, has become a problem.

As Latour summed up his career in his speech on the occasion of the awarding of the Unseld prize, he emphasised that it had not been logic that had led him from one theme to the next, and it was also not simple chance, but rather intuition, and indeed an intuition that, as he puts it: "[won] more resolution through a series of field studies which I carried out on technology" (Latour 2008, p. 6). The intuition of which Latour speaks was not something that was there from the beginning, but was rather built up over the course of researching various networks of translations. Beginning with the study of the problem of bible exegesis in Bultmann, via the research of laboratories, up until the investigation of an automated tube. Therefore, beginning with a very decisive break with that which healthy common sense would intuitively say is a promising entry into the technologically influenced social world, or even a meaningful starting point for the study of natural scientific rationality.

3.14 Theory and Praxis

> We must begin *wherever we are* and the thought of the trace, which cannot take the scent into account, has already taught us that it was impossible to justify a point of departure absolutely. *Wherever we are*: in a text where we already believe ourselves to be.
>
> —Jacques Derrida 1997/1967, p. 162

Intuition forms itself through a practical handling of things, which is never completely theoretically graspable. It guides a practical process of knowledge acquisition which is never completely theoretically graspable. In this, the trained body functions in a certain way as a medium between the things, technology, and scientific discourse. In this sense, Knorr-Cetina speaks of the researchers who "by means of their trained hearing and seeing function as embodied instruments" (Knorr-Cetina 2002, p. 52). Even the work on theory is a form of scientific praxis that is not completely theoretically graspable.

Purely theoretical processes of knowledge acquisition are thus, in a certain way, only theoretically possible, but practically impossible. Virtuosity is not acquired via the detour of explicit knowledge, but through dealing with technology. This is what makes it so difficult to talk about—something that anyone who has already tried to teach someone who has not grown up with computers how to use one can understand: one arrives quickly at the point where one is wrestling for words.

It is standard knowledge in psychology that, as a rule, one has no access to the reasons for those decisions that have been taken intuitively or to the reasons for intuitively drawn conclusions. However, this does not mean that they must be bad or wrong (cf. Nisbett and Wilson 1977). On the contrary: sometimes the attempt to explain them can block access to helpful intuitions, insofar as verbalisable reasons are pushed in front of non-verbalisable reasons, as Timothy D. Wilson and Jonathan W. Schooler (1991) have shown (also cf. Wilson et al. 1993). Whoever is interested

in how processes of knowledge acquisition run their course must, therefore, begin with the mechanisms which guide those processes, and those with which their results are justified or criticised. Wilhelm Wundt puts it so:

> At first one believed that one can best follow their [thought processes] tracks if one placed the laws of logical thought, as they have been laid out since Aristotle by scientific logic, as the basis of the psychological analysis of thought processes […] The attempt at explaining from these, in the psychological sense, even a small part of the norms of thought covering the thought processes, even for the developed consciousness, can only lead to weaving real facts up in a net of logical reflection. Indeed, one can say of these attempts that, measured against their success, they have been completely fruitless: they have themselves eliminated the psychic processes. (Wundt 1950/1912, p. 74)

If one uses the distinction between heuristic and analysis put forward by the mathematician George Pólya, then one can say that analytical thought is indispensable when giving reasons for the individual steps in a mathematical proof, or, generally speaking, justifying or refuting claims and proofs. Heuristic thought is indispensable when trying to find a mathematical proof, or, generally speaking, when it concerns gaining insight (Pólya 1949).

This distinction is based on the Greek meaning of heuristic as "something which serves finding or discovery" (cf. Goldstein and Gigerenzer 2002). The innovation of modern scientific and technological research correspondingly consisted in not concentrating on consecutive theories, but dedicating oneself to the everyday research practice in an investigative manner.

However, at least in the beginning, the scientists allowed themselves to get carried away with the typical explorative gesture of discovery, or, even better, of revealing or exposing: even science falls back on everyday heuristics—as if the ideal of a science independent of such an everyday heuristic could be maintained as a counterfoil. It is, however, not the case that these everyday heuristics in the daily life of science are added to theoretically controlled, and methodologically reflected, forms of scientific work, but rather permeate the whole experimental system in its execution. Rheinberger speaks of "extime reasoning", "in order to maintain the pragmatogonic dimension of the epistemic processes in the present and to escape the radical interiority of the Cartesian *cogito*" (Rheinberger 2005, p. 65).

Starting from Polanyi's insight that the course of an experiment follows "a series of rules, which are not present to the person who is following them" (Polanyi 1958, quoted from Rheinberger 2005, p. 65), Rheinberger describes what Wilson and Schooler observed as experimental psychologists, namely, that not only do the experimenters not have to be necessarily aware of such rules, but that they can even be a hindrance in their explicit form, or render the success of the experiment impossible:

> The effectiveness of such rules is based upon their subsidiary presence in the arrangement and execution of the attempts. These can include such seemingly simple maxims such as principles of symmetry, homogeneity and exhaustion, which are, however, only possible to keep to under ingenious conditions. All these rules are appropriated *in actu*, they cannot in themselves guide research, rather only accompany it as their implementation can take on a completely different form according to their respective field of activity. One draws a scaffold from that material protuberance of the imagination that one terms an experimental arrangement. (Ibid., p. 65 f.)

If it is not intention which primarily guides the process, but rather the intuition acquired in the experimental system, then beginning with a subject centred representation of experimentation is already, for practical reasons, impractical. According to Stengers description of the process of mutual tuning without a fixed centre and, at the end of which, virtuosity is to be achieved, experimenters can:

> well know in advance what they want to achieve—what, for instance, their appliance should detect. However, a long process of tuning will nevertheless be needed, within which nothing will be trusted, neither the human hypothesis nor the observations made. Indeed, the process of tuning works both ways, on human as well as on nonhuman agency, constitutively intertwining a double process of emergence, of a disciplined human agency and of a captured material agency. (Stengers 2008, p. 96)

The metaphor of "tuning" comes from Andrew Pickering, who, in a contribution which has subsequently become a classic of the newer research into science and technology, tried to more accurately describe the concept of "actors", often maligned as misleading, in the actor-network-theory, as well as that of the "agency" of non-human beings. Crucial to Pickering's approach is that he does not understand "agency" as something simply given, but rather as something that must first in the experimental process be given the possibility of communication:

> The contours of material agency are never decisively known in advance, scientists continually have to explore them in their work, problems always arise and have to be solved in the development of, say, new machines. And such solutions—if they are found at all—take the form, at a minimum, of a kind of delicate material positioning or *tuning*, where I use 'tuning' in the sense of tuning a radio set or car engine, with the caveat that the character of the 'signal' is not known in advance in scientific research. (Pickering 1995, p. 14)

3.15 Discoveries and Inventions

When one is dealing with a closed space such as an experimental system, which is simultaneously materially and semiotically disclosed up to the limits of perfection, then one is dealing with a situation in which the impossibility of the new becomes its condition. It is said that insight can only be experimentally gained via the route of invention.

Without the invention of the pedocomparator one could not compare areas of rainforest, without the invention of the high-speed centrifuge there would be no "105,000 × g-supernatant fraction" separated from the "microsome rich sediment", to which the attention of the scientists observed by Rheinberger turned (first they were cancer researchers, then they were biochemists, and, finally, molecular biologists), a cell supernatant which later turned out to be decisive for the "decoding of RNA" (cf. Rheingberger 2001, p. 90).

The explorer increases the probability of finding something by widening the area of his/her search; apart from courage and strong legs carrying him/her into undisclosed areas, it is, above all, the technological devices which enable this widening of the search area, such as faster ships or the Hubble telescope.

The experimenter, however, who artificially develops the disclosedness of his/her research space to an experimental system, closes it, until there is next to nothing left over which has not already been disclosed, who is not concerned with widening the search area, but rather, in delimiting the space, is not driven by the hope of finding something. S/he must hope to invent something which creates communicative possibilities for that which s/he does not yet know what it is. Neither the pedocomparator, nor the high-speed centrifuge, are inventions which were invented beyond their respective specific experimental settings.

While in an open space, such as the universe, the *amplification* of the magnification, and an *increase* in the precision, of a telescope allows us to look even further, the simple raising of the speed of a centrifuge in no way lets us look any deeper into the properties of a cell, just as the pedocomparator in no way lets the rainforest soil be better compared by having ever smaller compartments. It is a specific speed (105,000 × g) which proved to be significant, by separating out certain components without simply mashing everything together, and it is a *definite* degree of difference which allows the meaningful comparison of rainforest soil samples.

An invention is characterised by it never being foreseeable. It is much more an event, and only through this, through its relationship with the new, is it capable of taking on a decisive role in the process of knowledge acquisition.

Thus, the strategy of the experimenter consists, in contrast to the explorer, of bringing oneself into a situation in which one knows no further, in which one is unable to predict the next step. Derrida brings the description of the eventfulness of the invention to the pinnacle of the moment in which "[t]he event's eventfulness depend[ing] on this experience of the impossible" becomes evident (Derrida 2007, p. 451), and thus brings the invention into relation with the gift, without which, as Wimmer has shown, *Bildung* cannot be thought (Wimmer 1996a). "If I can invent what I invent, if I have the ability to invent what I invent, that means that the invention follows a potentiality, an ability that is in me, and thus it brings nothing new. It does not constitute an event. " (Derrida 2007, p. 450). That is why:

> For there to be an invention event, the invention must appear impossible. What was not possible becomes possible. In other words, the only invention possible is the invention of the impossible. […] If there is invention—and maybe there never is, just as there may never be giving or forgiving—but if there is invention, it's possible only on the condition of being impossible. (Derrida 2007, p. 451)

Therefore, if there is *Bildung*, then it is only possible under the condition of its impossibility (cf. Wimmer 2006, p. 379). And, it is also the reason why it is worthwhile for the theory of *Bildung* to look more closely at spaces such as the laboratory, which are permeated with strategies, and are themselves the result of a strategy, of concentrating the impossible. The laboratory is a strategically constructed space of the impossible (and not, as some believe, a place of unlimited possibilities[123]).

[123] For example, the Berlin chemistry Nobel prize winner Emil Fischer believed this when he, in 1902 in the best explorative manner, allegedly said: "The country does not need colonies, chemistry is the land of unlimited possibilities" (quoted from Christoph Stölz in the Berliner Morgenpost from 15.07.2009).

Inventions are thus also not primarily a matter for the "engineer", but rather the "*bricoleur*", as Derrida, in reference to Lévi-Strauss, puts it (also see Sect. 3.18).

Waldenfels, who also emphasises the moment of invention as the subversion of the sovereignty of the subject, writes that the invention lives "from an exchange between the bodily self and worldly things" (2004, p. 178); and, above all, they call for "the participation of the things" (ibid.). In this, the invented *bricolage* becomes connected together with the acquired intuition in the process of experimentation. Waldenfels covers this connection with the concept of "resourcefulness"—without him focussing especially on experimentation—and thereby refers to the Greek εύρίσκειν, or the Latin *invenire*, both of which mean both to find and to invent (2004, p. 162).

3.16 Intermediaries and Agents

It has become common in parts of the social scientific discussion to make the starting point of thinking about technology its basic indeterminacy.[124] Just as in the attempt at making the fundamental interminableness of knowledge the starting point for reflecting science, this, here, also concerns the humourless attempt (namely, without a ruse) at drawing immanent conclusions from the observation of a quasi-transcendental distinction. This is thus an attempt in which forgetting the necessity of the Re-Entry inevitably brings with it the loss of an empirical reference, and places one firmly on the sidelines of the game of forming the shared [*geteilten*] world, as a philosophical descendent of Hobbes.

For, just as the insight into the interminableness of knowledge is useful to no-one who is trying to gain insight, and especially not to one who is betting on the disclosure of the world, so the insight into the "indeterminacy" of technology helps no-one who is trying to unlock unforeseen possibilities, for themselves, and for others, in dealing with technology. Instead of orientating the thought of possibility toward the event, which would assume bringing thought to the limits of its possibilities, the concentration upon the indeterminacy of technology runs the risk of allowing technology itself dictating the possibilities of thought: namely, those associated with its indeterminacy.

What resonates in this figure of thought is a confrontation between technology and thought, in which technology is not the condition of possibility of thought, but is rather thought as its end, as something that one must escape from, in order to think beyond it and its determinations. Another perspective arises, however, when one places the insight at the beginning, that one cannot look beyond technology's determinations, and one also cannot escape these boundaries, when one analytically adds an indeterminate indeterminacy in thinking technology.

Instead of, in this way, inscribing technology with a general indeterminate indeterminacy, Latour determines the distinction between determinate and indetermi-

[124] For example, cf. Hörning 2001, Fritzsche 2009 and, for an overview, Gamm and Hetzel 2005.

nate as being dependent upon the respective application of a technological object. In his analyses, in this sense, he speaks sometimes of intermediaries, and sometimes of agents. Latour describes such entities that become quasi-causal functions in a network (here, a context of action is meant in the broad sense, or, more precisely: the result of a reconstruction of translation processes), as intermediaries.

A functioning processor, a cable, but also a whole power station, can therewith be understood—depending upon the focus of the analysis—as an intermediary: as an entity, the function of which is assumed, and so, not only does not require further attention (which, as a rule, it does not become), but can also be forgotten.[125]

However, Latour describes those entities as an agent, the operation of which—depending upon the focus of the analysis—would be impossible to ignore in an analysis, as something straightforward, functioning simply. The distinction is interesting because it transcends the distinction between human and non-human actors, and thus—as a further consequence—allows for an understanding of the processes of world disclosure, beyond the normal anthropocentric reductions, to be at all conceivable.

Thus Latour shows, using the demonstratively simple example of a bellboy, who has the task of opening the door for guests, how he can be understood as the intermediary of a chain of action (such as the procedure of checking into a hotel)—structurally analogous to a hydraulic door-closer (Latour 1988b). To remain within this example, the blocked hydraulic door-closer can equally be described as an agent, which triggers the reorganisation of the checking-in process via another exit, as well as the clumsy bellboy, who brings confusion to this procedure in his own way.

Therefore, in the context of an experiment, one has to deal with intermediaries, i.e. such elements which can be integrated as "black boxes" into the more or less fixed assemblage of technological boundary conditions, as well as with agents, i.e. such elements which, as communicating actors, seed an experimental system with the potential to surprise.

Only thus can it be seen that the experimenter has the *sole* task of maintaining the ambiguity of an experimental system. S/he must ensure that it neither tips into contingency, the mere co-existence of elements, nor that it becomes totally technological, and thus mere repetition, and so functioning as a whole as an intermediary, but is rather directed towards an *interplay* of various actors.

In other words, it is only because the experimenter has to deal, not only with intermediaries, but also with agents, that changes are at all possible. It hardly needs to be said that the difference between agents and intermediaries is not an essential one. Before the collection, before the translation, of single elements within an iterative context intermediaries are of no concern, for otherwise a translation would be both unnecessary and impossible—as an intermediary, however, an element can only be seen as the result of a translation, and can function as such only within the assemblage of a collection.

[125] Cf. Hörning et al. 1997, esp. p. 21.

3.17 Tools and Technology

> The answers given to the question What is Technology? Are appallingly superficial; and what is worse, this cannot be blamed on chance.
>
> —José Ortega y Gasset 1983, p. 297

After Stichweh described in what way experimental science is today radically materially-semiotically composed, as a logical consequence he referred to the central and transformed role of technology in this process:

> A precondition for this development is the dependency upon instruments and the technologisation of modern natural science. Technologisation embeds the physical model in an instrumental background, which, through this, renders it changeable, and thus interrogatable, and which can be unproblematically treated, at the same time, as a technological background to the experimental event, as in its manner of functioning at this time. Technicity means exactly this state of affairs of the temporary ability of looking away from questions of explanation and truth with respect to a functioning instrumental background. Technicity is, however, thereby as well a variable state, because it is dependent upon decisions each of which can fall in a different way, as to which functional conditions in a research process one wishes to consider to be unproblematic. (Stichweh 1994, p. 291)

And, when Fleck writes about Wassermann's initial attempts in researching syphilis, then he is also indirectly writing about technology: "[Wassermann's] preconditions were not maintainable, his first experiments irreproducible, and yet they were both of enormous heuristic value. And all really valuable attempts behave in this manner: they are always unclear, unfinished, unique. And when they are clear, precise and arbitrarily reproducible—then they are no longer necessary for actual research purposes, they are then only useful for demonstration purposes or specific findings" (Fleck 1980, p. 112).

In Rheinberger's words, an experimental system that no longer allows for surprises, but only functions in the way that it functions, thus letting itself arbitrarily repeat itself in the form of ideality, has become old (see Sect. 3.1). It can, however, still serve as a tool, but the iterability of its elements cannot be strategically exploited for gaining knowledge. If it is still being utilised for the acquisition of knowledge, then only as an instrument in an explorative process, or as a fixed element as part of the technologically limited conditions of another experimental system (in which it can be forgotten, such as a computer processor in a data simulation).

Accordingly, an experimental system which still produces surprises is still young, and, as such, is one in which the distinction between technological and epistemic objects is constantly deferred in the course of the epistemic process. With this, an essential determination of technology is excluded, and it does not matter for this determination whether it consists of metal, genetically modified cells, bureaucratic decisions, or programming code.

What is decisive as to whether something can be used as technology, and that means, above all, not necessarily being understood in different contexts, is whether its constitutive elements have collectively found a, more or less, (or at the limits of determination) fixed form. In Stichweh's words: "Technicity means exactly this state of affairs of the temporary ability of looking away from questions of explana-

tion and truth with respect to a functioning instrumental background." (Stichweh 1994, p. 291)[126]

Technology is therefore nothing other than a more or less fixed form of a translated context of elements. One can thus count as technology all the knowledge that can be presupposed, forgotten, and still mobilised as known knowledge, and fixed as a kind of black box, without this "black box" having to be reopened for this purpose, and the relationship of the elements to one another being understood.

So, one does not need to understand how a Geiger counter functions, but can still investigate the radioactivity of foodstuffs with its help. One can also mobilise the knowledge about Geiger counters, and their measurement of radioactivity without ever having held one in one's hands, and measured something with it. Elements are *more* fixed in the form of a "black box", so that the "black box" can itself be integrated within an experimental system as an element. Elements are *less* fixed in the form of an experimental system, so that this fixing them in their ambiguity is neither totally technological, nor totally indeterminate.

This is the outstanding characteristic of the experimental procedure, processing at the margins of possibility. The process itself decides what will, in retrospect, prove to be an epistemic, or a technological, object. Technology in the experimental system is, therefore, nothing other than the form of that which can be integrated into an iterative context as a stabilising element, and which can be iterated again and again, without one having to deal with something completely different. (In the context of the explorative system of thought, however, it is nothing other than a tool or a means to an intentional end).

The fact that one can assume the existence of a Geiger counter, together with its function of measuring radioactivity, without having to thematise this as knowledge, so that one can put together research on the relation between exposure to radiation and leukaemia simply on the basis of data collection, renders this knowledge, reduced to numbers, to an element that can be added, with other elements, to a fixed context, and so function as the technological limit conditions of an experimental system.

Without this fixation of the relation of elements it would not be possible to constitute any experimental system at all. The elements would simply co-exist in their untranslated form, next to one another. If technology is, however, that which enables experimentation as its limit condition, then it cannot simultaneously be fo-

[126] So, one finds in this experiment (the experiment with the aim of stabilising the concept of the experiment) different fixed components of knowledge in the form of "black boxes" as the technological boundary conditions of thought's entry. So, for example, the knowledge about the significance of technology, which is hard to overestimate, for the economic circumstances of a country, is a part of the boundary conditions of thinking technology insofar as it rules out from the very beginning the idea of the development of technology as planned and voluntary, just as it rules out the idea that one can come very far in talking about the social while keeping silent about technology—a limit condition that is technological insofar as it is here mobilised and can even be named (namely, with the corresponding literature references in the second footnote in Chap. I from Solov and Mankiw/Romer/Weil), which cannot, however, be individually—this reads, in a work of the human sciences, in a telling fashion, as a confession—at all understood—and that means here: by me, neither understood in the calculation, nor through an empirically controlled collection of data.

cussed upon within the experimental system of thought—it is, as limit condition, *qua definition*, deprived of this focus, and can, in a certain way, only appear in the corner of one's eye.

In other words, it disappears as that which enables thematisation as soon as one thematises it. That one has a tendency to confuse it with machines and tools is not because these are its preferred forms, but rather simply that its trace can still be assuredly assigned to it in this materialised form when one attempts to focus upon it as an epistemic object (and in so doing loses sight of it as technology).

Technology is thus (as opposed to its possibilities), *qua definition*, also nothing that one could explore. Whoever believes that it is possible to isolate, delimit, and describe technology in itself thus misses its necessarily tricky character (*techné*) and relies upon the character of the tool.

Whether it is more appropriate to understand technology with respect to its tool like character, or with respect to the moment of trickery, is dependent upon its use. This tricky use of technology is characterised by deferment, by a certain moment of surprise. When something is translated within, and through, technology, then the trick consists in the redefinition of the opening situation, according to the possibilities of the given technology.

The use of technology as a tool is not of this character. Technology can only then be used as a tool when a translation is not necessary, because the opening situation has been engineered to such an extent that only a means to an end will be replaced by another means to an end (the redundant post office clerk, responsible for stamping, is replaced by the stamping machine, or one stamping machine by a newer one). This may be because the opening situation is already preformed with respect to the existence of this technology (the memory stick is a tool for transferring data only because it was produced in the awareness of the possibilities of data transfer—no-one first produces data, is then confronted with the problem of how to transfer it, and is then, as a consequence, surprised by the possibility of transferring data).

Whoever uses technology as a tool thus strives for goals which already meaningfully exist in the shared [*geteilten*] world as possibilities. It logically belongs to the nature of technological development that its tricky character disappears with time, to be replaced with a tool like character. Because the appearance of technology itself changes the world, and, with this, is not simply a neutral, additional option, introduced into the world, the tricky character of technology really does disappear, and becomes empirically replaced by its tool like character.

Only from the background of a transcendentally thought, and thus undivided, [*ungeteilten*] world, could one arrive at the idea that technology's tricky character is simply lost from sight, and increasingly *appears* to be a tool. On the basis of the changing world itself, on the basis of the fact that these technologies have taken part in its division [*Teilung*], technology remains conspicuous for precisely as long as the difference it makes is still compared with the world which it does not yet divide [*geteilt*].

3.18 Engineers and Bricoleurs

If technology has a form that is characterised by the fixation of elements,[127] but cannot be used in an experimental context as a mere observational tool on the undisclosed which is to be disclosed, because that which is the focus of concern is absent, and the distinction between technological objects and epistemic objects must remain in motion, then dealing with the technology of an experimental system presents itself as something that, at the same time, has a decisively non-technological character. Rheinberger writes that scientists "are, above all, 'tinkerers', bricoleurs, rather than engineers" (2001, p. 30, also cf. here Sect. 3.13) in order to describe this non-technical handling of technology.

So, while the engineer primarily progresses in a controlled and planned fashion (thus, just as it is regularly insinuated that the experimenter does), the experimenter primarily proceeds in a tinkering fashion. Because there, instead of a defined goal, an unforeseeable result is striven for, technology cannot be used as a means to an end (as a tool, in the categories chosen here). This is why the experimenter must tinker with technology, and why it remains impossible for the experimenter to march off, and search for what s/he wants. Instead, s/he takes that which is ready to hand:

> [those] instruments he finds at his disposition around him, those which are already there, which had not been especially conceived with an eye for the operation for which they are to be used and to which one tries by trial and error to adapt them, not hesitating to change them whenever it appears necessary, or to try out several of them at the once, even if their form and their origin are heterogeneous—and so forth", writes Derrida in explaining Lévi-Strauss' concept of bricolage. (1978, p. 285)

So, taking "the place of a targeted project, for which the appropriate means for its realisation are provided, […] [is] a reversed procedure which tests the available tools for their possible use in the most different of contexts, and so produces 'unpredictable results'", writes Quadflieg in explanation of Derrida's interpretation of Lévi-Strauss (2007, p. 266).

Waldenfels also states, with reference to technological innovation necessarily accompanying such an epistemic process, that such "unpredictable results" do not thus emerge out of nothing, but also neither in the form of a rule, which can be derived from the given circumstances. According to him, these innovations "always [contain] a moment of re-working, restructuring, the reforming which includes the deviation from a normal level" (Waldenfels 2004, p. 165).

The experimental researcher, who is always tinkering with translations of translations, does not tinker with tools during the day in the laboratory, and then, in the evenings, translates the results into concepts. That would assume that there exists a hierarchy of radicality between the radical breaks in the translation steps, in which

[127] This is not an answer to the question what technology is. This question is replaced by the question what, in different contexts, counts as technology, and how is it relevant in this respect for processes of world disclosure. This work is exclusively concerned with the role of technology in the experimental processes of knowledge acquisition, and that includes the question what counts as technology in this. Beyond that, the concept of technology will be regarded as ambiguous.

the step up to the desk, where the theoretical work is done, is more radical than all the previous translation steps, which can all together be forgotten as being epistemically secondary. How could one think this, however, one could add together with Derrida, without once again employing a transcendental signified,

> which in and of itself, in its essence, would refer to no signifier, would exceed the chain of signs, and would no longer itself function as a signifier. On the contrary, though, from the moment that one questions the possiblity of such a transcendental signified, and that one recognizes that every signified is also in the position of a signifier, the disctinction between signified and signifier becomes problematic at its root. (Derrida 1972, p. 20)

Human and social scientists were, for this reason, already on the wrong track. They thought they had to teach natural scientists something about the role of language in their science, instead of thinking about what they could learn from the natural scientists about tinkering.

Thus, when Derrida talks of bricoleurs then one should not understand that as a metaphor. "If one calls *bricolage* the necessity of borrowing one's concepts from the text [*of which there is no outside*] of a heritage which is more or less coherent or ruined, it must be said that every discourse is *bricoleur* [*and every bricolage is discourse*]." (Derrida 1978, p. 285) And, because of this, the experimental handling of technology is also joined together with the experimental at the theoretical level within Lévi-Strauss' concept of bricolage. For Lévi-Strauss's most remarkable attempt (ibid. p. 286), as Derrida writes, consists in understanding on the methodological level what he designates using the concept of bricolage—for Lévi-Strauss talks about language when he speaks of the bricoleurs. This "remarkable" achievement of Lévi-Strauss—implementing, on the methodological level, what is being talked about with the concept of bricolage—means, with reference to the mythological discourse with which Lévi-Strauss is concerned, becoming "mythomorph" in the discourse about myths. "The discourse on the acentric structure that myth itself is, cannot itself have an absolute subject, or an absolute centre. It must avoid the violence that consists in centring a language which describes an acentric structure, if it is not to short-change the form and movement of myth" (ibid. p. 286).

Every lapse can thus be traced back to an anchoring "to a *centre*, to a *subject*, to a privileged *reference*, to an origin, or to an absolute *archia*" (ibid. p. 286). Derrida then opposes this mythomorphic discourse to science: "Therefore it is necessary to forego scientific or philosophical discourse, to renounce the episteme which absolutely requires, which is the absolute requirement that we go back to the source, to the centre, to the founding basis, to the principle, and so on" (ibid. p. 286), only to immediately afterwards show that Lévi-Strauss' implicit critique of language also attacks the concept of the *episteme* itself. There, where "ethnographic *bricolage* deliberately assumes its mythopoetic function […] makes the philosophical or epistemological requirement of a centre appear as mythological, that is to say, as a historical illusion" (ibid. p. 287).

This, as Derrida shows, indeed escapes Lévi-Strauss, and so he maintains the distinction between bricoleur and engineer as more foundational, and therefore, does not extend the insight gained, decisively enough to cover the whole of the field of the *episteme*. Translated into the formal theoretical distinction between experiment

and exploration, this means that one must also understand the distinction between bricoleur and engineer as a quasi-transcendental one, which can only be made in the form of its own Re-Entry—a necessity, if one wishes to continue to empirically distinguish between the engineer-like handling of technology in the explorative system of thought, and the bricoleur-like handling of technology in the experimental system of thought, without anchoring these fundamentally.

Just as one can distinguish an explorative approach from an experimental one, one can distinguish between the bricoleur and the engineer, as two separately legitimate ways of handling technology in the invention of technology. For, just as nobody can develop a technology without always already having been able to fall back on technology which is ready to hand, nobody can, vice versa, simply tinker, without at the same time using technology as a tool, just like an engineer.

It is self-explanatory that one, with reference to bricolage, "must distance oneself from the idea of a centre, a subject or a privileged reference of the language system" (Quadflieg 2007 p. 267). The lapses of the scientific theoretical discourse about the experimental can be traced back to the fact that, analogous to Lévi-Strauss' endeavour, experimentally researching the experimental has been unsuccessful. In other words: the experimental can neither be disclosed nor described within explorative conceptuality, it can only be thought within the experimental system of thought itself.

3.19 Collecting and Assembling

It becomes apparent in the concept of the bricoleur how exploration has prepared experiments, and exhausted its own possibilities in their increasing disclosure of the world. Not only because they have increasingly disclosed and closed the world, but also because the experimenter cannot do otherwise than fiddle with the things assembled around him/her, if s/he wants to bring them into an insightful relationship with one another. However, collection, and therefore exploration, precedes assembly. In the popular idea of the expedition, the aspect of collecting (that of bringing-home) is often neglected when compared to that of discovery (that of striving-into-the-unknown). Even worse: it is often laughed at for its quirkiness.[128]

However, it is this collecting and assembling, this laying side by side, and comparing, which first of all allows the recognition of the difference that provides the impulse for fundamental changes to the categorical schemata being used. This, in turn, allows the bricoleur to take what is ready to hand (cf. Drouin 1994 for a historical perspective). If everything depends upon the choice of a system, as Rheinberger writes, then everything also depends upon the collection and assembly of that with which the experimenter, as tinkerer, can tinker with.

[128] For example, in the characterisation of Alexander Von Humboldt in Rainer Simon's film "The Ascent of Chimborazo" ["Die Besteigung des Chimborazo"] DDR 1989.

3.20 Isolation and Assembly Structure

If, in an experiment, the disclosedness of the world is increased, up until the limits of perfection, through the closure of a space in the world, in order to open up possibilities for an absent other [*Fremden*] to communicate [*Mitteilung*], through the strategic exploitation of the iterability of its material-semiotic composition, so that one has to regard technology as an irreducible medium of insight in the same way that language, and the distancing to an object of knowledge, is recognisable as a retrospective fiction, then no object can be isolated as a subject for observation. It is much rather the relations of all the elements involved in the iterative event in their assembled structure which form the potential source of unforeseen events.

Of course, no experimental system can itself generate knowledge as if it were an "intelligent machine". But, thought is likewise dependent upon the experimental system when it is directly concerned with thinking within one. Thought within an experimental system refers to the practical nature of this thinking, and so to the "silently" acquired intuitive knowledge. Rheinberger distinguishes between two "complementary modi of extimity":[129]

> Both are of a material nature and refer to each other successively. Afterwards, the silent knowledge of the subject has its form and its place in the technological apparatus of the experimental system, while the subsidiary attentiveness opposingly embodies this apparatus with its tools on the part of the subject. I wish to call this dual structure of reciprocal intervention, and reaching out, attention [*Augenmerk*]" Rheinberger. (2005, p. 64)

This attention, with its "subsidiary attentiveness" is something decisively different to the focussed observation of an object by an explorer. It is characterised by its unspecific orientation, while the quality of the observation of an explorer can be measured by its precision. Rheinberger seizes the metaphor of the spider's web in order to describe the form in which all that silent knowledge, with its more or less explicit epistemic rules, which was earlier termed intuitive, is employed in dealing with the experimental arrangement. A spider's web in which the unforeseen events can make themselves be known in decentralised fashion, which is also why "the corner of one's eye […] is attention's proper place" (ibid. p. 67).

With that, the boundaries of an experimental system are, at the same time, delimited. They are equally determined by the technology, and its ability to collect heterogeneous elements in a context capable of iteration, and by the boundaries of the experimenter's "subsidiary attentiveness". That the boundaries of thought are determined by technology in this way does not necessarily mean that the areas of research so determined are done so in an ontological fashion, it is rather that which is to be thought must be adapted using a correspondingly rigorous translation of the respective possibilities of thought and attentiveness.[130]

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[129] See above in relation to the "silent knowledge" (Polyani) on the concept of extimity in Sect. 3.14.

[130] See also Sect. 3.7 above.

Those disciplines in the humanities, for instance, which rely only upon techniques for concentration and memory, as opposed to those that have an exteriorised recording and categorisation system at their disposal, have more a roughly woven "net" available, that enables them to consider things that have long ago been forgotten. While an experiment is concerned with allowing the span of attention to be spread as widely as possible by collecting heterogeneous elements, whose communication could potentially surprise within a common iterative context, in exploration, the focus is on a given aim, a research object at the centre of events. Even in the humanities, such work in which a given object comes into focus, and is researched with the aid of theoretical or methodological tools, can be distinguished from those in which the relations of the elements involved themselves become the object of attention.

The development of every *complex* theory is thus characterised by its assembly structure, in which it is less the origin of its concepts, and the precision with which they describe something, and not just anything, which are crucial, but rather much more their relational connection to one another. This is a context which cannot remain unchanged due to the integration of newer elements and the appearance of unforeseeable events (and because of this, it requires a certain flexibility). The positive in such a theory correspondingly consists in its ability to rearrange its assembly structure in the course of integrating new elements, while the positive in an exploratively applied theoretical tool is rather measured according to how precisely it can record the object to be observed. In other words, in exploration everything turns around the research object, while the experiment lives from the restlessness of its long term reinvention.

3.21 Transcendence and Immanence

Whoever goes on a journey of discovery into open space does not first need to divide the world, since that towards which his/her research efforts are directed is in an area of the world which has already been disclosed as undisclosed. For the explorer, the distinction between disclosed and undisclosed is therefore itself not a problem, insofar as it is already there and will be drawn upon. Whoever now considers the past only in terms of the present, i.e. as the presented past, and locates the origin of the distinction between world and non-world outside of the world, can present his/her discovery to him/herself, others, and god, as a disclosure of an undisclosed interiority of the world (cf. Luhmann 1990, p. 58 ff. and Berr 1994).

From this perspective, the explorer merely completes the picture of a pre-given world, in which its division is purely additional, and thus can be understood as a partition. The explorative does not collapse if the exploration is unable to exhaust the pre-given disclosed undisclosed, or, in hermeneutic words, in the fulfilment of a pre-given conceptualised expectational horizon (Buck 1981, p. 50) through its disclosure, because the disclosed has proved itself to be undisclosed, or undisclosed as disclosed.

The explorer can ignore the fact that the distinction between disclosed and undisclosed *itself* changes in the movement of disclosure, and not just elements being transported from one side to another in some kind of set theory, disqualifying it as a "mere philosophical" problem, or tidying it away in the as equally positive as metaphysical history of scientific progress, for as long as s/he manages to find certainty in the trust in an instance extracted from this process, which lends his/her efforts stability.

The explorer will never have been concerned with the disclosure of a past undisclosed within a recursive identification with the present past, but rather always only with the disclosure of a present undisclosed. The undisclosed that s/he attempted to disclose might well have proved to have been non-existent, and the disclosure actually refers to the existence of something else, of which s/he had no previous idea because it was for him/her undisclosed. It might even be that previous knowledge has proven to be erroneous, and is itself presently recognisable as potentially open for revision—as long as the explorer's point of reference is a world which stands opposed as a corrective to his/her understanding, exploration provides its own legitimation, its legitimation as the continual and world renewing disclosure of an undisclosed.

The distinction between the world and its image serves as a transcendental anchor, which can be imagined as a removed *différance*. God and nature are the most popular transcendental figures which secure this anchoring of knowledge of the world; this knowledge that is actually only directed toward the sensible, the worldly, and thus the immanent, which essentially means that the world itself is on the line in exploration (nothing else is meant if the distinction changes itself).

God is the traditional name for the origin of the world beyond the world (the origin of the difference between immanence and transcendence in the transcendental). The explorer investigates a world, the origin of which, understood as the already-made distinction between immanence and transcendence, is located not in the world itself (in the immanent, evoking transcendence), but instead, beyond it (in the transcendental, constituting immanence).[131] When Columbus began his journey, he personally obtained the Pope's assurance that his travels were in God's service. Wherever he then went, and whatever he then did, he knew with this assurance[132] that he was always within God's world, and beneath his eyes.[133]

Columbus might be an unusual example, insofar as he already had ideas, which were not exactly contemporary for his time, of undertaking a crusade to the West.

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[131] With Luhmann, one can understand god in this way in the sense of a formula of contingency, whereby god, "realises the complete features of transcendence, in particular the trait of boundlessness, of being everywhere, and so the ubiquity also in the realm of immanence, and so the unity of the difference of transcendence and immanence." (Luhmann 2002b, p. 151). Also cf. Luhmann's reading of Nikolaus von Kues in Luhman 1992b, p. 529, note 96. In a less Christian diction one could also speak of the world as cosmos, and of the rest about which one cannot speak, as chaos.

[132] The insurance salesman with specialisation in acts of god would be sent later by the reinsurer. On the Metaphysics of Reinsuring cf. Schneider 2005.

[133] "God", according to Luhmann, "is defined as a person because that establishes him as an *observer*." (Luhmann 2002b, p. 157).

As Todorov shows, Columbus gave the Pope no room for doubt that his journey served "the glory of the Holy Trinity and […] the holy Christian religion" (Columbus quoted from Todorov 1984, p. 10) (and the search for gold, the preparation for the final conquest of Jerusalem).

That the explorer's trust in god later increasingly shifted towards nature as a transcendental instance, with its unchangeable laws, structurally changed nothing in this metaphysical order; and, as many of the intermediate steps show (e.g. god as creator of natural laws etc.), trust in god, and trust in nature, are not necessarily in conflict with one another. Much has already been written regarding this, and it does not here need to be further explicated. However, what is of interest here is the difference between this explorative order of immanence and transcendence, and the experimental order of immanence and transcendence—a difference, which, due to the persistence of the explorative system of thought, is, as a rule, not taken into consideration, but is actually no less fundamental than the difference between observation and processing, and the other distinctions explicated in the above.

However, contrary to the consideration of the distinctions presented above, this should not now concern what really distinguishes the experimental approach from the explorative, independently of the ideas of the explorers and the experimenters, but rather what characterises the distinction between an explorer who misjudges the immanent structure of exploration, and the experimenter who misjudges the immanent structure of experimentation. This is not because the ideas of the experimenters and the explorers were themselves interesting, but rather because they are, as part of the world, effective in reality, i.e. co-constitutive of the world.

This means, translated into the terminology chosen here, how do the experimenter and the explorer distinguish themselves in their forgetfulness of the Re-Entry and the repression of the impossibility of the processing of the quasi-transcendental distinction between disclosed and undisclosed? Both cases are concerned with a *displacement* of the division [*Teilung*] of the world, insofar as an undivided "world", established in the transcendental, becomes an object of their efforts.

The efforts are so directed towards a quasi-transcendental distinction, while, at the same time, an immanent one is worked upon—the shared [*geteilte*] world is thus simultaneously formed, and neglected. In both cases, a reference is thus made to the shared [*geteilte*] world as undivided [*ungeteilte*], and, with that, the political and ethical moment of every effort at world disclosure, which resides in the "co" of the communication [*Mitteilung*], and is the object of the claim of the other [*Fremden*], is rejected.

If the division [*Teilung*] of the world is rejected in the course of its disclosure that does not mean that it disappears, or that the image of the world threatens to become corrupt, but rather that it comes down to rejecting the divisions [*Teilungen*] of the world itself. From the perspective of the theory of *Bildung*, this consideration will later become significant above all for the question regarding the relationship between science and *Bildung*, and for the question regarding the processes of *Bildung* of the scientists themselves.

While the explorative sciences thus require an instance deprived of immanence, such as god, or nature, in order to maintain their undivided sovereignty in the world,

the situation in the experimental sciences is fundamentally different. One most easily recognises this by the minor importance of theories and critiques of science assigned by science itself. Critiques of science working on exploration never tire of pointing out that science too, no matter how scientific it may be, has no exclusive access to the world as it really is; there is hardly a text about science in which the "constructive character" of the scientific "model" of the world is not pointed out.

This form of the critique of science has never given up the Hobbesian claim to knowing better, but has simply changed its initials. In this form the "world" is seen as something non-disclosable, and its disclosure removed as a problem, instead of understanding the world as a necessary, quasi-transcendental, effect of the efforts at disclosing the world (see below).

For the experimenter, this critique, with its associated explorative boundary questions, such as those regarding the possibility of being able to access nature as it is in itself, according to the possibilities of god's laws, or nature's ("the crisis of representation", the problem of the non-neutrality of the observer, the problem of objectivity,…), is not just irrelevant, but next to nearly unintelligible. For, while explorers disclose god's work before his eyes, or the laws of nature (trusting in their unchanging effectiveness), by trying to disclose their effect through exploration, the experimenter is not at all interested in some sort of correspondence between his/her own model and a transcendental one.

They are neither concerned with looking at god's plan, nor with looking at the laws of nature. They do not look above, in the "starry skies", but rather below, at the world in all its profanity. For a halfway reflective experimenter, there is no doubt that theories and formulaic natural laws are of a human, symbolic nature, models are models, and constructions are constructions. Just as little as Hobbes's objection, that he could not recognise the real truth at all, had interested Boyle in those days, does the objection that they cannot recognise real truth, interest the experimenters of today.

This attitude which appears worldly-wise, gives the impression that experimental science is, in a certain way, completely secularised, and is characterised by a decisive break with pre-modern science. The work in the laboratory in which function, and not correspondence, is crucial, gives the impression of the most consequent reference to immanence. Put pointedly, alone the fact that some experimenters do not listen to Bachelard, and continue to do a bit of philosophy in the evening, that there are scientists such as Steven Weinberg, who do not cease to propagate the prospect of the discovery of a universally valid world formula, provides the classical critique of science sufficient material to convince itself of its own legitimacy.

However, the impression of enlightenment is deceiving. For, the division [*Teilung*] is also rejected by the experimental side, but here, this rejection takes on another form than in exploration. This misjudgement stands, like all other characteristics of the experimental, in a non-contingent context, assembled with all the other characteristics of its system of thought, and necessarily distinguishes itself fundamentally, in every single aspect, from the explorative. Just as disclosedness in the experiment is met with closure, a closure which raises time over space as the primary source of the new, requiring the iteration of the non-technological handling

of technology, the absence of the other [*Fremden*], which renders every representation impossible, and forces the experimenter to translate, and so, to an intimacy with things, the intimacy of the experimenter over time, and with every iteration, allowing the experimenter an increasing familiarity with the complexity of the experimental system, so that s/he acquires an intuitive capability, through practice, to track deviations, a feeling, and a capability, to maintain a space of indeterminacy which stops the iterative events from falling either into the mere repetition of the mechanical, or the mere chaos of open worldly events, it is, vice versa, impossible for the experimenter to secure his/her sovereignty, like the explorer does, through locating him/herself at the centre of a given world, in the centre of a field of determinacy that s/he might extend in the direction of the horizon, in the course of his/her investigative efforts.

In order to gain an idea of the position of the experimenter in the immanence-transcendence-texture one can, once again, return to the "Ur scene" of the scientific experiment, to Boyle's air pump experiment. An extremely graphic depiction of this structure can be found in the painting *An Experiment on a Bird in the Air Pump*, by Joseph Wright of Derby in 1768.[134] Here, the position of the experimenter within the experiment's immanence-transcendence-order, seen from the perspective of one of the scientists rejecting the division [*Teilung*] of the world, is thematised.

Wright—and this is what creates the attraction of this painting—did not need to create a new iconography in order to portray the relationship of transcendence and immanence in the experiment, exactly as Boyle himself did not have to invent a whole new epistemology in order that his results obtained validity. Just as Boyle fell back on the existing technology available to him by translating the techniques of interrogating witnesses from the legal system, Wright also fell back on existing techniques of the representation of the transcendental, and translated the iconography of sacral painting into the context of experimental science.

The continuity with the religious immanence-transcendence-order thus remains recognisable, while, at the same time, the break with it becomes clear. Wright, a member of the important scientific society, *Lunar Society*, painted the picture both as an artist, and a natural scientist (cf. Krifka 1994, p. 18 ff.). It is, therefore, not only an illustration of a scientific self-understanding, but also, equally, a document (Fig. 3.1).

The critique of the experiment, which remains bound up in the explorative system of thought, does not cease to emphasise that the natural scientists, too, only have "mere" models of the world, and their theories, in their obvious sociality, and linguisticality, cannot be identical with the building plans of creation. They thus kick the technology, which enables continuity amongst the change of theories, once more into forgetfulness, and so completely remain spellbound by the staging of the experiment, which is precisely aimed at the ability to forget technology, and the work of translation.

[134] One can find a freely accessible and high definition version on the page of the London National Gallery under http://www.nationalgallery.org.uk (As of 10.08.10).

Fig. 3.1 Updated Caption for this image: Joseph Wright 'of Derby' 'An Experiment on a Bird in the Air Pump', 1768. Oil on canvas, 183 × 244 cm. (Copyright © The National Gallery, London. All rights reserved)

While, during the process of knowledge acquisition, technology must be decisively mobilised as an irreducible medium, it must be freed, *ex post*, of every epistemological participation in order to understand it as a *mere* medium, as a mere means to an end, and so be able to degrade it to the status of a tool. In this sense, Wright does not depict the process, but rather the result, although he places the technology, the air pump, at the centre of events.

The way that Wright stages the air pump in his picture has less the effect of a technologically constituted medium, in the middle of the translating tinkering of a bricoleur, as much more a distanced medium, in the sense of a séance. The air pump here loses its profane character, and is surrounded by Wright with the insignia of the sacred. It is depicted as a medium in the hand of the experimenter, who, with its help, mediates the transcendental.

Most striking in Wright's painting is the light: he stages the light with a decisive shift with respect to traditional sacred painting—here, it is the apparatus that lights up those present, as only the baby Jesus had done in the centre of a group (for a detailed account of this cf. Schöne 1954). The interpretations of the picture by Thomas Fink and Phillip Weiss point out the relationship of this light with the *candle lights* of Utrecht's Caravaggisti, insofar as, here too, light, with its strong accentuation, creates a dramaturgy that marks the climax of a particular scene.

The concentration on a clearly delimited space, fashioned by the light, in which the various dynamics are bundled, and intensified, creating tension without a conduit to an exteriority. The look and the gesture, including the gaze of the observer which is bound up with that of the experimenter, obviously Boyle himself, refer to one another, without finding an exit or end point immanently within the picture. The centre holds the tension without discharging it, and even the moon in the window, acting as a second source of light, serves as an echo of this scene, rather than taking on the function of a discharger of tensions.[135]

The source of light itself remains unseen, just like the divine light itself that allows things to appear, illuminating them without being present. This, according to Werner Busch, corresponds to the graphic depiction of the bible passage in which it is said that Jesus is the light of the world, except that, here, it is once more the light of knowledge that has taken the place of baby Jesus (Busch 1986, p. 33 ff.).

That which is here presented by Wright as the glow of knowledge is, in the eyes of Hobbes, much more the frail appearance of a fraudulent play of shadows. There is no bridge, not even an iconographic one, between the experimenter's claim to truth, and those who hold onto the explorative, privileged access to truth of Hobbes' philosophy. For, while Wright stages the transcendental relation to truth via the experimenter, he also appears to simultaneously illustrate all of Hobbes' prejudices about the work of the experimenters.

Hobbes writes that these "Fellows of Gresham" are just mere "selected members of a dubious private circle who meet under the auspices of some sort of authority; one has also recently heard of an 'Invisible College', which is supposed to meet in London" (quoted from Fink and Weiss 2001, p. 1). However, Wright's depiction appears private;[136] the esoteric character of this meeting is additionally underlined in his painting by the darkness demarcating the seclusion of the circle of participants.

Against the suspected darkness of the publicly unseen circle of scientists, who meet in rooms with limited access, instead of publicly in the Agora, Hobbes—naturally—contrasts the light of philosophy. A self-written dialogue with Boyle (mind you: both his, and Boyle's, roles were written by him) in *Physical Dialogue*, begins with a clear assignment of roles, referring with little subtlety to the cave allegory in Plato. He sketches a scene in which he himself stands in the glaring light of the sun, and receives a blinded Boyle "as if this one had stepped directly from his experimenter's cave into daylight" (Fink and Weiss 2001, p. 2), and lets him then immediately say: "I am pleased, that you have asked me to come; but I can truthfully see nothing as the brightness of such a clear day blinds me." (Quoted from ibid.).

Wright does not attempt to weaken the experimenter's claim to a transcendentally valid truth; on the contrary, he fully exhausts the iconographic loan from sacred

[135] A principle which is to be found in nearly all of Wright's paintings, with the exception of the later landscape paintings, and serves at the same time as a symbol of the Lunar Society (cf. Fink and Weiss 2001, p. 4).

[136] It is, however, not a dressing gown—even if it looks like one—which the experimenter is wearing in this painting, but most probably the coat of a philosopher or a scholar. This is what outrages Hobbes when he—and in no way metaphorically—complains that this experimenter covers himself with the coat of a philosopher without asking.

painting. Busch is thus able to go even further in his interpretation of the picture. The experimenter, in accordance with Christian iconography, is presented in a clear allusion to the representation of god the creator by Wright. Busch sees the frontal presentation, the prominence emerging from the crowd, as in the painting *The Last Judgement* by Michelangelo Buonarroti, on the altar wall of the Sistine Chapel, and a vertically shifted gesture of ensoulment, as in the painting *The Creation of Adam*, as possible models for Wright (Busch 1986, p. 46).

And, finally, the similarity to god is even underscored by the depiction of the event itself. The hand of the experimenter marks the boundary between the life and death of the bird threatened with suffocation, by touching the apparatus' opening valve. He can give the bird life by opening the valve, and letting air in, or death, by withdrawing air.[137] Busch points out something else in his analysis of the painting which is still related: the experimenter is already behaving in a godlike fashion in the very fact that he has created a vacuum—he creates and controls a state before creation, a state before the world, when god was alone with himself; and from this state the experimenter can breathe life into the bird.[138]

That is the same, Hartmut Böhme also concludes in his discussion of the depiction of the vacuum in this painting, as "occupying the metaphysical position of god" (Böhme 2003, p. 16, cf. also Busch p. 43). The bird is sacrificed on the altar of enlightenment. What must also be sacrificed, Böhme adds, is the attitude of humility before the divine. The "traditional feelings of fear and terror, pity and care that have been the works of religion" would now be "signs of immaturity which are especially attributed to the female public" (ibid.). In this spirit Erasmus Darwin, just like Wright a member of the Lunar Society, poeticised the air pump as a transcendent, powerful instrument—received from the hands of sylphs, able to produce a primeval emptiness:

> You charm'd, indulgent SYLPHS! their learned toil,
> And crown'd with fame your TORRICELL, and BOYLE;
> Taught with sweet smiles, responsive to their prayer,
> The spring and pressure of the viewless air.
> —How up exhausted tubes bright currents flow
> Of liquid silver from the lake below,
> Weigh the long column of the incumbent skies,
> And with the changeful moment fall and rise.
> —How, as in brazen pumps the pistons move,

[137] The indecisiveness of the end result is also underscored by certain other details that Benedict Nicolson points out: "That uncertainty is expressed in the ambiguous role of the boy by the window who holds the cords of the birdcage: is he to let it down to receive the revived bird, or sling it higher because the bird will have died? The reactions of the audience vary greatly, from the youngest child's first acquaintance with the possibility of death to the old man's evident reminder of its inevitability. The man who comforts the small girls may be reassuring them that all will be well, or expounding the inevitable laws of nature. A detached observer on the left of the table has taken out his watch to time the progress of the experiment. A boy stares upwards, fascinated. A young couple on the left clearly have their own more agreeable preoccupations. The reactions of all these people have been (and no doubt will continue to be) variously interpreted." (Nicolson 1968, p. 60).

[138] On this cf. also Genz 1994, Chap. 2.

> The membrane-valve sustains the weight above;
> Stroke follows stroke, the gelid vapour falls,
> And misty dew-drops dim the crystal walls;
> Rare and more rare expands the fluid thin,
> And Silence dwells with Vacancy within.—
> So in the mighty Void with grim delight
> Primeval Silence reign'd with ancient Night.[139]

The mighty void, primeval silence: "In the act of creation god breathed pneuma into the world, bringing life to the dead material by means of the divine breath, and now man can take over this function" (Busch 1986, p. 43).[140] Busch's further interpretation is not absurd given the context of the scandal that the technological creation of a vacuum had caused. He sees in the white bird—probably a cockatoo—a reference to the dove in Christendom, the symbol of the Holy Spirit: "Whereby here, which is almost difficult to say, the Holy Spirit is pumped out" (ibid., p. 46). The boy at the window, the only one apart from the experimenter who looks at the observer, completes the trinity of father, son and Holy Ghost (ibid., p. 47).

As a member of the Lunar Society, and thus a part of the early natural scientific experimental movement,[141] Wright did not deliver an artistic interpretation from outside,[142] or even an external critique about the hubris of science. He utterly correctly depicts the principle of the experiment in a world thought of as undivided [*ungeteilt*]: The Re-Entry of the distinction between transcendence and immanence, on the side of immanence, after the forgetting of the Re-Entry itself. Busch therefore correctly surmises that it does not concern a "real experimental scene", but rather the portrayal of one of the "lectures on Pneumaticks", which "travelling scholars, equipped with natural science", on "tours of the provincial towns", undertook for those citizens interested in the new natural science (ibid., p. 26).

Nothing new, then, just a tour. It is, however, not only probable that it is not concerned with a real experimental scene, as Busch surmises, it cannot be dealing with a real experimental scene. It is only because this is no longer an experiment, but a demonstration of an experiment, a performance, in which the experimenter has the

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[139] Erasmus Darwin (1788/2006): The Botanic Garden. A Poem in Two Parts. Part 1: The Economy of Vegetation. Project Gutenberg, EText-No.: #9612. Busch, who references this poem, translates the last two lines as follows: "So regiert in der nächtlichen Leere mit grimmiger Freude/ Uranfängliches Schweigen mit uralter Nacht" (Busch 1986, p. 66).

[140] Busch follows this aspect further on the basis of the iconography of nothingness.

[141] The Lunar Society was anything but an esoteric private club, it members stood at the centre of social development and had the available means to anchor their scientific discoveries in society. Members included e.g. Matthew Boulton and James Watt who welded science and industry closely together with their steam engine, the politician and engineer Richard Lovell Edgeworth who spread the ideas of his friend Rousseau among English industrialists and teachers, the theologian Joseph Priestley who, among other things, discovered oxygen, James Keir, who, as a chemist, revolutionised glass production, and as a soap manufacturer revolutionised British hygiene; even Benjamin Franklin was a regular guest. For more on the Lunar Society cf. Schoefield 1963.

[142] In fact, he was almost nearer to natural scientific circles than to those of art, especially since the Royal Academy, which was oriented more toward central European development, and had little time for Wright's representational historical painting, and refused him full membership (cf. Krifka 1994, p. 6 ff.).

process and the results in hand, because it thus concerns a bird killing machine, and a machine of social distinction, that the experimenter could appear as father with his son, and the half pumped out Holy Ghost.[143]

Thus, the experimental sciences do, in fact, take up the position of religion when they begin to take care of the distinction between transcendence and immanence. They do not, however, thereby attempt to observe god, but rather to recreate his work; in a certain manner they do not look upward to him, but rather sit themselves in his lap and look down. The way to god is now no longer through the recognition of his work, but rather through understanding it. Whoever knows about air and its pressure, can remove it and give it, just as god did when he breathed life into being.

The more that one knows about how the world *functions*, the less one needs a figure such as god; one does not even need a figure such as nature, in the sense of an *explanans*; whether god (or nature) is taken into consideration or not, becomes increasingly like the decision as to whether one adds the factor one in a multiplication sum or not, and one can understand Julien Offray de La Mettrie as the historic figure who carried out the symbolic crossing out of this one with large gestures—with a portrait of the world according to the model of an experimental system that has degenerated to a demonstration of an experiment, that is solely technological (cf. La Mettrie 1988/1748).

Michel Serres has shown, using the example of Paris in 1800, how the scientific community, at first slowly, and then within a very short period of time—namely in 1800—occupied the position of the clergy in the social realm. After a scientific community had established itself, it behaved as an organisation towards the individual scientific societies of Boyle's time (such as the Royal Society, of which he was a member, or the Lunar Society, of which Wright was a member) like a state religion acts towards individual sects. Science had so appropriated the organisational structures of religion that it could easily take on its traditional tasks and, above all, its institutionalised positions of power and influence.

For Serres, these positions of power and influence were such that they were mainly situated beyond discontinuous politics: it was the positions of advisors, teachers, institute directors, secretaries, civil servants etc. And all these positions did not have to be newly invented, but rather only had to be reintegrated, sometimes including the persons occupying them.

This was made possible by the fact that that which binds the clergy, just like that which binds science, is removed from the immanence of politics, and is mediated via the reference to a transcendental instance. Just as the clergy constituted itself through the reference to god, the scientific community constituted itself via a reference to a transcendental instance—nature, or the facts: "No functional or structural difference separates the belief in a transcendental god from the belief that a scientific object exists independently of us […]. The transcendence remains in both cases the same. And the social consequences remain unchanged." (Serres 1994, p. 643).

[143] Normally, one does not, of course, keep the same apparatus after a fixation of the facts for, in the "long term a degenerated research system […] will, as a rule, be completely replaced by a technological system that embodies current, stabilised knowledge in an efficient form" (Rheinberger 1992, p. 28).

In this sense, Serres describes the change in positions not simply as a break, or even as a conflict, between two powers, but rather, above all, as a structure surviving beyond the *Ancien regime*. With that, what Wright had depicted as a manageable private meeting, completes itself on a larger, social scale: namely, the acquisition of a transcendentally legitimated position which imaginarily overcomes the division [*Teilung*] of the world.

The idea of a horizon being continually extended, as a consequence of a movement in the open space of an undisclosed disclosed space in the world, in which the observer, aiming at discovery, always stands at the centre of events, and can so forget his/her own position, is a useless metaphor for the experiment, and does not offer an idea by which the experimenter can orient him/herself. For, the fact that the experimenter makes disclosedness the starting point for his/her research, and must, therefore, view the world, no longer as an open space, but as closed [*geschlossenen*], and so including him/herself, allows every possible perspective *within* that space to be recognisable as already located, which leads to the situating of the perspective (cf. Haraway 1988).

However, exactly as the explorer was able to save his/her sovereignty through a transcendental reference, the experimenter may save his/her sovereignty by transcendentally mediating his/her reference to the world. But, because the distinction between disclosed and undisclosed crosses from the other side of the equation, s/he must adopt another strategy.

While the explorer saves his/her sovereignty through degrading the foreignness [*Fremdheit*] of the other [*Fremden*] to a simple foreignness [*Fremdheit*]—in that s/he locates the other [*Fremde*] on the side of the undisclosedness of a previously divided [*geteilten*] world, and does not recognise it as the communicator [*Mitteilende*] itself, the experimenter saves his/her sovereignty through removing him/herself from the entire scenery, bringing his/her own situatedness to disappear, and thus crosses the co- [*Mit*] from his/her communication [*Mitteilung*]. In both cases, the division [*Teilung*] of the world becomes a division [*Teilung*] within the world.

If a shifting horizon no longer guarantees the centralised perspective (cf. Giesecke 1998), because the experimenter works in a closed space depicting the world, then the only thing left that can save his/her sovereignty is taking on a perspectival position *beyond* this space, and viewing this space *as a whole*. The distinction between disclosed and undisclosed thus coincides with the boundaries of the experimental system that depicts the world, so that the scene portrayed by Wright is really controlled by an experimenter who has the *whole and undivided* space of immanence in his hands.

The experimenter, who, in the laboratory, works on the distinction between the disclosed and undisclosed *in the world*, while s/he believes that s/he has *copied* it into the laboratory, who, therefore, not only observes and describes the world, *but grasps* it, fiddles with it, has it in his/her hands, needs no missionary, and no priest, who mediates with god in his/her entourage, and must neither assure him/herself

that s/he is on the right path by visiting the pope. For, s/he can see the world from god's perspective, from the position s/he has occupied.[144]

This is the free-floating eye, with its glance from nowhere, of which Haraway said, that it *knows* the world ("this eye *fucks* the world to make techno-monsters" Haraway 1988, my emphasis; also cf. Haraway 1997b). The explorers might have neared god in many respects, above all in their cruelty, but they never believed that the sum of their knowledge would bring them in his position; they always saw themselves on the earth, and god in heaven. But the experimenters, who have turned everything that characterised exploration on its head, but have still kept one thing, namely "forgetting the Re-Entry", believe that the sum of their observations can be put together to make a picture of the world that would correspond to god's creation with a probability[145] sufficient for any reasonable person.

This is not the struggle of an enlightened science against the superstition of religion, as told by the heroic history of science, and what the physicist Steven Weinberg means, when he answers the question whether the world formula (the possibility of which he certainly believes in) would replace god with an unmistakeable "No": "No. We are not replacing god. We're economising him. The world formula would be the last step of the way which Newton and Copernicus first took: developing an image of the world which can manage without god." (Der Spiegel 30/1999, p. 191).[146]

A more apt illustration of the continuity of the self understanding of experimental science could hardly be made. For, in the argument with Hobbes, and the dispute with his philosophical claim of being able to distinguish between validated truth and mere opinion, Boyle counters with his ruse of inventing a kind of truth that no longer needs this claim to truth. This manoeuvre is structurally similar to Weinberg's, who, in the dispute with the modern defenders of religion, and the critics who reproach science with the hubris of "wanting to play god", tending a god who alone is able to know the world as it is, shrugs his shoulders, and answers that he does not want to replace god, but is rather only concerned with an image of the world "that can manage without god".

In the explorative understanding of the relationship between religion and science, *science always progresses ever further*, in the transformation of superstition into knowledge, and thereby *reduces* the claims of religion making statements about the world to the mere moment of creation as the origin of the distinction between

[144] Of course, only ever partially, but always as a *summary* part of a scientific project aimed at a totality.

[145] On this cf. Sect. 2.5.

[146] "An exclusion of religious ideas from physical thought would only then mean a denial of god if it would be claimed that the physically explained world depicts the totality of the creation. This opinion is today held by dialectic materialism, but the majority of contemporary scientists regard the exclusion of religious ideas from the world of physics nothing more than a clean delimitation between physical knowledge and the truth of faith. It is the demarcation of this boundary that first gives the nature of physics an inner unity and thus the character of a scientific system." (Schrey 2000, p. 1625).

immanence and transcendence. Every positive insight is thus counted as a partial victory of the facts, over the fantasy images of belief.

In the complementary version of this idea, it is discussed, based on concrete cases, whether science *has gone too far*, here and there, in enabling interference in the world. Even locating which areas of life should be covered by its claim to validity, and which not—a question which Litt, for example, has extensively covered in the area of educational science (cf. esp. Litt 1959, first chapter)—can be understood as being explorative. One can say with certainty that nothing can be expected for the understanding of the experiment from this way of discussing science—whether it has gone too far, or whether it presumes godlike powers. This is not because, individually, these are not important problems, but rather because here an explorative understanding of the experimental approach is used, and it is therefore misrepresented.

The belief that one could demark scopes of validity within the world, not only divides the world into areas in a highly problematical way, into those in which "modern science" should remain silent, and those in which everything else has nothing to say, it reduces the whole question of science to one of its scope of validity—instead of understanding it as a question about the form of the shared [*geteilten*] world. Such forms of the thematisation of science appear almost inevitably—for no-one wishes to appear irrational, and to argue against facts witnessed by reasonable persons—in the shape of rearguard actions, at the end of which stands the transcendental itself, in a certain fashion, the last refuge, as the place that must remain spared by the validity claims of "modern science".[147]

The critique of science in the explorative system of thought persists in the attempt at tackling these transcendental pretensions, again and again, by trying to demonstrate the constructive nature of knowledge—as if this would provoke a halfway reflective experimenter, who anyway presumes never to have done anything else than construct things, to doing something else other than shrugging his/her shoulders and continuing on as before. Being "halfway reflective" does not mean understanding the experiment experimentally, but rather knowing that one constructs, but believing that it does not matter. Knowing that the criticism of one's own scope of validity is unjust, and *simultaneously* proceeding to experiment as if one was exploring, that is a problem—for whoever changes the shared [*geteilte*] world while believing that that s/he is only observing, produces distortion in that place where s/he rejects the division [*Teilung*] of the world.

Early studies of science exposed the transcendental validity claims of science, and thereby took on the position of the ironist (Stengers 2000, p. 66 ff.). However, the science critic cannot here refrain from insuring himself in the transcendental: "They know they will always encounter the same difference in point of view between themselves and scientists, which guarantees that they have conquered, once and for all, the means for listening to scientists without letting themselves be im-

[147] This culmination in the theological can be found, for example, in Litt (1957), or in Peukert (1976).

pressed by them." (Ibid.) There are ironists who know this and try to take it into consideration without, however, being able to free themselves from this dilemma:

> Some authors can advocate an 'ironic' reading of their own texts because the latter are equally scientific (dynamic irony). The fact remains that the position in principle requires a reference by the author to a transcendence (stable or dynamic), to a more lucid and more universal power to judge that assures his or her difference from those being studied. (Ibid.)

The task now consists of not declining the responsibility, which was always already present in the claim of the absent other to communicating [*Mitteilung*] a shared world, but rather by approaching the other as a part of a shared world and experimentally participating in its division, which is as much to say, accepting this claim as a call for *Bildung*. This cannot occur ironically, but only with the total seriousness of an attitude which brings humour with it, understood as the "art of immanence" (ibid.). No task which is only possible on the basis of its impossibility, and upon which one can only work if one begins right in the middle, with the necessarily insufficient resources that one has at hand, and in which one must bind oneself, as closely as possible, with a part of the world, in order to appropriately translate it, and so be able to share [*teilen*] it, can be undertaken without the willingness, and the ability, to laugh. With reference to science itself, at the beginning of which stood the de-partmentalisation of a world of the worldly sciences, and in which this experiment here (the experiment of granting the concept of the experiment with a connectable constancy in relation to the theory of *Bildung*), must be located, this means:

> The difference between science and nonscience cannot be judged in the name of a transcendence, in relation to which we would designate ourselves as free, and where only those who remain indifferent to it are free. For our dependence on this transcendence in no way reduces our degrees of liberty, our choice as to the way we will attend to the problems created by the constitution of this difference. The situation is the same as that of politologists, who know that their problem would have no meaning had not the Greeks invented an 'art of politics.' They are themselves a product of this invention, which they thus cannot reduce to nothingness. But they remain free to put this invention in history. (Ibid., p. 66)

3.22 The Experiment from the Explorative Perspective

In the eyes of the explorer, experimental work represents a singular scientific disaster. Instead of modestly beginning with the available knowledge about one's own non-knowledge, the experimenter presumes everything possible as known knowledge, and even mobilises that which s/he does not understand. Instead of beginning with what is unknown, s/he excludes everything which s/he cannot be sure of gaining access to. Instead of going out into the world, which s/he claims to be researching, s/he locks him/herself in, and others out. Instead of extending his/her view, s/he restricts it. Instead of at least attempting to observe the world as it is, s/he has already modified it before even beginning with an experiment. Instead of reducing the number of investigative steps, in order to come nearer to his/her object of investigation, s/he multiplies them.

At the same time, s/he gives up any pretence at distance, and involves him/herself in the event. The handling of concepts in the process of experimenting is vague, even sloppy—even if, at the same time, it is a kind of moderate sloppiness that Max Delbrück described as necessary for every experimental knowledge acquisition process.[148] The employment and handling of technology must also be imperfect, in order to maintain the material-semiotic space of the experimental system in its vagueness between chaos and mere repetition.

The expediency with which an experimenter switches his/her attention from this to that must be extremely irritating for an explorer, who never lets his/her target out of his/her view, especially when the only reason for a change of direction is a mere feeling that something, somewhere, appears to be missing. Even the layman can see that the experimenter never has the world around him/her in the laboratory, and anyone who looks closer would see that not one of the many steps of translation is logically derived on the basis of a rule; no concept, no object, where it cannot be proven that it had another meaning in its original context to that which it has been translated into.

Instead of correctly doing something precise, everything here is dealt with as if it is probably or sufficiently right. Wherever one looks: artificiality, cracks, possibilities, tricks and tinkering. This is why every experimental work inevitably appears as immodest and imprecise to the eye trained in explorative thought: instead of dedicating oneself to doing one thing right, all sorts of heterogeneous elements are bundled together into an assembly.

Since the first production of a vacuum, the experiment has been a singular source of horror for the classical scientific understanding searching for clear distinctions. It has, quite literally, produced brutes, the offspring of logical paradoxes, such as florescent mice, whose single, natural environment is the artificiality of the laboratory. However, when rooms close by themselves, when there are hardly any uncharted regions to fill in, theories, technologies, and epistemic objects, have become global, then the explorer bumps into him/herself and his/her findings, everywhere.

This leaves one with only three possibilities: firstly, the flight into the imaginary, in which one, as economics has done over the past thirty years, invents the object to be explored, or is successful in what some tourists occasionally achieve when they travel outside of the tourist season. Or, secondly, by doing science like a notary, in which one produces quotable texts regardless of their insightfulness. The third possibility consists of facing up to this fact and the paradoxes that result from it.

The experiment *is* the technological-social solution for the paradoxical attempt at disclosing a disclosed world. And, although the paradox is nothing that exists in reality, it cannot be renounced when thinking world disclosure, because it is only via the detour across this quasi-transcendental instance that the thought of world disclosure can range beyond the explorative. No-one can disclose something without simultaneously distinguishing between the disclosed and the undisclosed; other-

[148] This turnaround can be found in a letter from Delbrück to a friend (from: Rheinberger 1997, p. 258; 17).

wise there would be no possibility of connection with something. This "something" is the world—and thus something that necessarily points beyond itself.

3.23 The Explorative and the Experimental System of Thought

When one creates lists of characteristics, and tinkers with them for so long, until they have stabilised to such an extent, that one can then fixate them as a unity, then the *following* act of naming is no longer an act of describing a previously undescribed object. But, the fact that one is searching for the "right name" already indicates that this naming is also not a neutral act, but rather a form of translation—an attempt to inscribe something in scientific discourse which has not been foreseen.

When one thinks in this way, starting from assembling, tinkering and translation, instead of from a definite theory, in order to investigate an object defined as indefinite, then the criteria of the respective theory which can define an object as an object in the first place, together with the corresponding identifying concepts are absent. This forces the invention of concepts in order to provide the stabilised list of characteristics with a name for each entity, so that it can further circulate as a "black box".

Here, in this experiment, it is the terms "experiment" and "exploration", or "*Bildung*" and "learning", that have imposed themselves as names for the stabilised list of characteristics, as two complementary forms of world disclosure. It was thereby shown that it is not simply an observable essentiality that is being dealt with in experimenting and exploration, but also not simply theoretical constructions. If it concerned explorative, uncovered discoveries, then a *baptism* of these newly discovered entities would have been manifest.

In an experimentally gained distinction between two forms of world disclosure, which only obtain insightful value in their distinction to other forms of understanding world disclosure, it is manifest that existing concepts be taken in order to render apparent the continuity, and the break, with tradition. At the latest, at this point, where the self-referentiality of this experimentally gained distinction becomes more than clear, the question as to the place from which this distinction between experiment and exploration is made, forces itself to the fore.

Experiment and exploration are forms of world disclosure, whose character decisively depends upon which ideas they are accompanied by; this is something that is not only valid for reflection, but also the execution of the strategies—for, as strategies, they are neither means, nor methods, in the hands of an intentional subject, but rather the form of thinking itself.

When experimenters experiment in the belief that they are exploring, then this is not simply a problem of the reflection on the experiment, but rather a problem of thinking itself, and thus for all that which is "known" in the course of this process, and for all those who have to live with the consequences, and the associated exclusions.

When the reference to a transcendental instance is used as a legitimation for leaving the form of the processes of world disclosure as if the world were undivided [*ungeteilt*], then this has a real effect, and leads to the exclusion from the division [*Teilungen*] of the world.

Finally, if the distinction between exploration and experiment can itself only be understood as the result of an experimental (and not explorative) process, then exploration and experiment are two forms of world disclosure which themselves, in turn, cannot be observed, or conceived, from a third, independent standpoint, or only from a standpoint from which the distinction itself can appear as defect, or as an error, but not as something that can be witnessed from an independent side.

That such a standpoint is absent was already clear from the form of the dispute between Hobbes and Boyle. To repeat schematically: instead of persuading Hobbes according to the rules of the dominant rationality (namely, Hobbesian), that the truth can be demonstrated using the experiment (which would not have been possible), and instead of persuading Hobbes according to the rules of neutral rationality (such a neutral or overarching rationality is absent), Boyle must use a ruse, which, while not persuading Hobbes, allows Boyle to achieve another aim which can leave him no less satisfied: he brings everyone else to orient themselves according to the experimental equivalent of truth, and to gradually ignore Hobbes' objections as "merely philosophical".

In this respect, oriented toward the unbridgeable break, the transition from explorative to the experimental[149] is the same as a paradigm change in Kuhn's sense, or a change in the style of thought in Fleck's sense—however, only in a limited fashion. What makes it impossible to understand the experimental and the explorative as a paradigm, or as a style, of thought is the fact that one has not replaced the other, but that the appearance of the experimental in the history of rationality (which does not mean the same as with the origin of the experimental itself) had "merely" broken with the universal dominance of the explorative in science.

Only by taking into consideration such a closed off area as physics was it possible for Kuhn to understand a paradigm change as the complete transition between two mutually exclusive paradigms. Admittedly, even this, as is known today, was not correct—after all, physics still works with Newtonian mechanics, even after Einstein (one could say that they have different paradigms for different energy levels on standby)—but it certainly cannot be true when one is concerned with the understanding of the technologically mediated processes of knowledge acquisition as a whole.

Kuhn's concentration on theoretical transformations, together with his neglect of technological continuities, speaks against the concept of the paradigm, while the systematicity and the assembly structure, in which the characteristics of the respective strategies of world disclosure mutually refer to one another, speak against

[149] The historic change of significance in science is meant as the transition. If one grasps experiment and exploration abstractly as general strategies of world disclosure (which is always here implied, and will be subsequently explicated), then experiment and exploration are, strictly speaking, of course, of the same origin.

Fleck's more flexible concept of the style of thought,[150] which one could otherwise introduce as an alternative.[151]

The suggestion, which is really not much more than a conceptually embarrassing fix, is that the explorative and the experimental are to be understood as two complementary systems of thought. With this, on the one hand, the systematicity with which its characteristics refer to one another within an assembly should be emphasised and, on the other hand, it should be pointed out that no form of world disclosure can manage without thought. This thought, instead of being imagined as free-floating, is subject to the limiting conditions of each respective system of thought—for, the thinking of world disclosure can only cross the boundary between the disclosed and the undisclosed in the world (therefore, via a Re-Entry), and, respectively, only in one direction (and not simultaneously taking both sides into view)—which is also valid for the thought that is attempting to disclose the strategies of world disclosure.

As systems of thought, Kuhn's paradigms, and Fleck's styles of thought, have in common the absence of an overarching rule, a higher rationality, in which the transition from one to the other could in turn be subsumed. The absence of such a common fundament becomes above all clear in the reference to the thinking of world disclosure itself—here there is clearly no unbroken transition from a universal *explorative* understanding of world disclosure to an *experimentally* gained understanding of world disclosure, as *either* explorative *or* experimental.

A crisis at the end of the universality of the explorative system of thought also recalls Kuhn's paradigms, which always then appear when the foundation of rationality itself is at stake. Kuhn speaks of the accumulation of many smaller crises, the appearance of diverse ad-hoc theories, the suppression of facts, or even the acceptance of blatant contradictions, which announce such a change. And one can see, with Fleck, the "insistent tendencies of the system of opinions"[152] (Fleck 1980, p. 40) at work, that lead to holding onto a form of thinking, despite this obviously being at its end, which is shown through an increasing complexity and the accumulation of exceptions.

Various indices can be gathered for the thesis that the explorative manifests a system of thought that, for some time, has already been in the midst of a crisis of its universality. One could thus reinterpret the "crisis of representation" as a part of the explorative crisis. Or, the astonishing attention paid to grasping every form of the gaining of knowledge, with all the associated difficulties, as an "observation":[153]

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[150] It is flexible insofar as Fleck's style of thought, which among others, orients itself according to gestalt psychology, is within limits presented as being extensible, modifiable and malleable. On Fleck's theoretical references cf. Schäfer and Schnelle 1980.

[151] Kuhn's concept of paradigms borrows substantially from Fleck (cf. Schäfer and Schnelle 1980).

[152] Fleck—always the experimenter—is not especially consistent in his conceptuality. The concepts of thought collective, style of thought and system of opinions are not clearly cut distinctions between one another: also cf. Schäfer and Schnelle 1980.

[153] One way out is, of course, to grasp observation so abstractly that it can be abstracted from the eye and the view, as is the case with Luhmann, who grasps observation as making a distinction. In what respect a remainder of the primacy of the look is to be found even in Luhmann, must be

That a research problem that is so seldom understood, such as the observational dilemma in quantum physics, has drawn so much attention can, in this respect, be understood as a symptom for the crisis of the primacy of observation. This attention is not only remarkable because the significance of the observational dilemma in quantum physics is hardly understood by anyone, or, almost virtually misunderstood[154] by everyone, but also because the problem of the influence of the observer on the observed had long before been discussed as a problem in areas such as ethnography. Evidently, however, it first required a crisis in the "universal language of science" (Carnap 1931), physics, before it could be seriously accepted as a fundamental problem, even concerning scientific rationality itself (via the detour of a decisive misunderstanding, of course). As long as only ethnography, or the social sciences, were concerned, one could use this as proof of their insufficient scientific method, (which would correspond to a sort of ad-hoc theory about the maintenance of the universality of the explorative).

In the light of the close link between objectivity and a delocalised view (cf. Daston 1999) in the explorative paradigm, such phenomena can now be understood as symptoms of the threatened universality of a thought system. In contrast, the distinction between the explorative and the experimental opens up the possibility of thinking every form of world disclosure as a world internal work on the boundaries of the world, in the form of the Re-Entry. This, in turn, allows one to further meaningfully distinguish between such observations which leave their object unchanged (such as the observation of the moon through a telescope), and those which necessarily influence their object (such as the participating observation of a social group). This is without, in the first case, claiming to see the things as they are "in themselves", or, in the second case, putting forward the idea that one must only reduce the influence as much as possible, and then the things would show themselves as they are "in themselves".

The attempt by some constructivists to draw the absurd conclusion from quantum physics' observational dilemma that every observation influences its object can be understood as the almost despairing attempt at saving, if not the universality of the explorative system of thought, then at least universality itself. One could count further symptoms of the crisis: the "discovery" of the constructive character of science, its irreducible historicity, its tendency towards social closure, the significance of everyday heuristics, the formative character of the media, the tendency towards virtualisation etc. But all of this firstly only led to a critique of exploration

tested against the question whether observation in system-theory can also be grasped as processing (I guess not).

[154] The observational dilemma in quantum physics is mostly misunderstood as a practical research problem, as a problem of the physicist with being able to observe his/her object without "influencing" it. In this misinterpretation the possibility of an independently existing reality functioning according to the classical laws of physics (such as those of causality) remains untouched. In fact, it is all much more worse, and not only unintelligible, because it is complicated, but rather because it is in fact impossible to grasp what happens. An understandable depiction of this unintelligibility can be found, for example, in Lindley 2008.

which, having its own claims to universality, itself came in the explorative form, and was rightly understood as an attack on the validity of science.

As such, scientific reflection developed into a kind of production studio for crisis theories. No dialectic was able to leave the spell of this crisis, such as that suggested by Rorty for philosophy, when he, following Kuhn, distinguishes between a "systematic philosophy", in the sense of a normal science, which should carry on working as if there has never been a crisis, and an "educational philosophy", which should pose a kind of permanent critique against the tendency of this systematic philosophy towards closure, its tendency towards a "becoming technological" (cf. Rorty 1979).

The only thing which can help break the spell of this crisis fixation is by turning towards the experimental, which aspires neither to replacing the explorative nor to destroying it. This is what one can learn from "experimental science": it succeeded in turning the boundary problems of exploration systematically into an advantage. One no longer strove for absolute truth, but rather made do with the currently most persuasive; instead of searching further for uncharted regions, one concentrated on retrieving the known from its interior; instead of journeying further, one began to remain on the spot, and, instead, used the time strategically; instead of convincing oneself that research only then began when media had become so transparent that one could forget their influence, one began to place the tinkering with the media at the centre of the research process, and to measure the way to represent the represented, not according to its correspondence with the object, but rather by its ability to connect; one rendered the historicity of science to its own condition, the invention became the motor of progress in knowledge, reserved intentional, achievable goals for research proposals, and otherwise relied upon intuition, upon the feeling that one is on the trail of something.

That the margins of experimental science are bordered with challenges to *Bildung* is because science must always constitute itself anew in the de-partmentalisation [*Ab-Teilung*] of the world. Whoever, or whatever, may here communicate [*mitteilen*] is a question which exceeds science—it is the foreboding of those who have an idea, who are confronted with these challenges to *Bildung*. And, it is, of course, not just scientists who have an idea what is concerned in the communications [*Mitteilungen*] of science, for, it does not concern a particular scientific world—every form of experimentation presupposes a closure of one of its spaces of heightened disclosedness of the world, which depicts the world.

This is the necessary act of division [*Teilung*] that must precede every experimental effort, in order to open up the possibility for the co-mmunication [*Mit-Teilung*] of an absent other, and to be able to do justice to its claim to communicate [*Mitteilung*]. The division [*Teilung*], the exclusion, the rejection of the world, and the imperfection of the translations, thus become the conditions of possibility of being able to deal with the consequences of the divisions, exclusions, rejections, and imperfections.

One remains a crisis theoretician of explorative insight when one remains dedicated to the failure of the explorative system of thought (if one always points to something new, that knowledge is interminable, that media are not neutral, that the

other is not dissolved in ownness, that there is no access to a world in itself, that representation is in crisis, that the intentional subject is at an end etc.).[155]

Thinking in either of the two systems of thought is a thinking within an assembly, i.e. that no characteristic can simply be exchanged, and every characteristic within the respective system of thought always refers to every other characteristic, and first takes on its meaning within this differential, referential network. As such, to state only some of the possible cross references, one cannot think intuition together with the sovereignty of the subject, placing it in the position of the intention (otherwise one would end up with self-help literature), one cannot think iteration spatially, one cannot speak of construction, and rely upon representation (otherwise one ends up with trivial constructivism with a tendency towards solipsism), one cannot explore disclosed spaces (otherwise, one would become a tourist), one cannot tinker with the eye, and see with the hand, one cannot speak of the iterability of an experimental system without simultaneously recognising that experience sediments itself in the body of the experimenter.

One can also not recognise the historicity of culture, the culture of science, without simultaneously recognising the historicity of nature (otherwise, everything falls apart: a nature thought of as a constancy is a transcendental nature), one can also not translate without losing one's distance, just as one cannot escape the responsibility for one's decisions, when one translates.

These mutual references of the elements to each other, their integration in the assembly of a system of thought, provide the distinction between exploration and experiment its fixed form. One can even translate this fixed form into a table.[156] While, in such a great step of translation, nearly everything is lost, and the connections become distorted, it can still serve as an overview, and is helpful insofar as those aspects alluded to here, but do not have their own section dedicated to them, and thus do not appear in the table of contents as a particular chapter heading, are also recorded.[157]

In the first part of the table on the next page, the left side is assigned to the explorative, and the right side to the experimental. In the second part, the left side is assigned to the explorative understanding of the experiment, and the right side is assigned to the experimental understanding of the experiment.

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[155] This is what Rabinow reproaches Rorty with: this is also no better than the analytical philosophers who would have transformed philosophy into a technical discipline when he does nothing more than repeatedly announcing the end of philosophy according to the same schema (Rabinow 2004, p. 119).

[156] This tabular confrontation draws from Donna Haraway's (1991) Cyborg manifesto, in which two types of concept are oppositionally opposed: those bound up with the idea of natural objects and those that subvert this idea.

[157] However, as a translation and on the basis of its clearly discernible reductions they can also serve in Serres' sense, as an amusement. (Serres 1992, p. 7, see also above Sect. 3.8).

Exploration	Experiment
Undisclosed	Disclosed
Extension	Limitation
Open	Closed
Space	Time
Unlimited possibilities	Limited impossibilities
Repetition	Iterability
The other recognised as foreign	The absent other
Eye	Hand
Transparent	Opaque
Observation	Processing/work
Objects of research	Epistemic objects
Copying	Modifying
Natural	Artificial
Representation	Translation
Distance	Proximity
Intention	Intuition
Discovery	Invention
Few preconditions	Many preconditions
Links	Mediator
Tools	Technology with *techné*
Engineers	Bricoleurs
Collect	Gather
Isolation	Assembly
Alexander von Humboldt	Wilhelm von Humboldt
Transcendental immanence	Immanent transcendence
Ahistoric	Historic
Learning	Bildung

Philosophy of science	Study of science
Vienna	Lwów
Primacy of Theory	Primacy of Praxis
Simulation	Virtuality
Irony	Humour
Ethics of conviction	Ethics of responsibility
Genius	Virtuosity
Publication	Co-mmunication [*Mit-Teilung*]
Present absence	Situatedness
Disembodiment	Embodiment

Chapter 4
The Subversion of *Bildung*

You don't have to be a scientist todo experiments on your own heart

—Jeffrey Lewis

At the beginning of this work stood a definition of *Bildung* as a fundamental transformation of the figures of world and self relations, as a result of the experience of failure. Beginning with the assumption that it is no accident that, when one speaks of *Bildung*—and, indeed, in this form—it is mainly technology that is ignored. The example of experimental science was used as an empirically accessible form of world disclosure in which technology so obviously plays a significant role and it was shown that the attempt at keeping silent about technology must lead to an equally obvious breach of the empirically understandable character of the experiment.

Here, reference could be made to previous investigations. Thus, it was only necessary to gather, assemble, and translate, into a theoretical context equally capable of supporting both paradox and iteration, that which was already to hand as known knowledge, and supposed to be relevant for the question regarding the absence of technology in the theory of *Bildung*. In the course of tinkering around with the assembled results of the more recent studies of science and technology, the question regarding technology, and its relation to *Bildung*, increasingly stepped into the background, and was gradually relieved by the growing suspicion that it was not the absence of technology itself that was concerned, and thus also not the attempt to remember it, but rather that the possibility of answering the question of technology is dependent upon something totally different, something that finally proved itself to be—*ex post*—the absence of a separating distinction between two complementary forms of world disclosure.

So now, instead of providing an answer to the question as to which role technology plays in the processes of the transformation of the figures of world and self relations, this discussion delivers the answer to two questions, which had not been asked before this experiment had begun. On the one hand, this is firstly the question regarding the distinction between learning and *Bildung*—a question that was accepted as having been answered. And, on the other hand, it is the question regarding the appropriateness of a definition of *Bildung*, as a "fundamental transformation of the figures of world and self relations, as a result of the experience of failure of the existing figures of world and self relations".

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The question, in this form, did not appear to be meaningfully answerable, for, without an explicit reference to a previously present theoretical elaboration, this generally held version of the concept of *Bildung* appeared, on the one hand, much too open and too indefinite, and, on the other hand, much too limited—finally, what is here under consideration is hardly more than one, admittedly central, turn—in order to recognise it as a worthwhile object of research. Rather, it would have been natural to ask how, and with which theory, such transformations could be better understood and described.

4.1 Bildung and Learning

If one conceives of exploration and experiment as two complementary forms of world disclosure, derived in the manner shown above, then no difference structurally exists between the forms of world disclosure drawn from either organised labour or the individual. In both cases, work on the distinction between the disclosed and the undisclosed is the matter concerned, and both cases are concerned with the disclosure of a shared world [*geteilten*]. That is just as well—otherwise, one would have to deny either science, or the individual, the ability for world disclosure, or claim that the "world of science" no longer had anything to do with the "world of an individual".

The "world of science" would be defined as the totality of those areas which count as scientifically disclosed and scientifically undisclosed, while the "world of the individual" would be defined as the totality of that which lies before the individual as disclosed and undisclosed. The quotation marks already indicate that a solipsistic concept of the world is not here of concern, but rather a paradox (there are an infinite number of worlds—but never more than one), which enables the simultaneous thought of its division [*Teilung*] and inaccessibility—and thus to locate the processes of world disclosure there—and *exclusively* there—where they also take place: namely, in the world.

That every form of world disclosure is oriented toward a shared [*geteilte*] world is already a result of the form of world disclosure itself: within each moment of world disclosure the division of the world into a disclosed and an undisclosed region must be actualised, for, this effort can only be directed to one of the two sides, and, only in making this decision does a motive for world disclosure step forward (only because everything is not disclosed to one is there any motivation to disclose something, and only because one suspects that the disclosed world is not as it is depicted to one, does the motivation to follow this up exist).

That the world beyond this is also still shared [*geteilt*] with others, is equally, necessarily, involved with this—for, otherwise, there would be nothing foreign in the world, whereby there would be no "co" in the communication [*"Mit" in der Mitteilung*], no motive for world disclosure, together with no disclosure, and, finally, there would not even be a world.

The necessity that, in every case, it is the disclosure of a *shared* [*geteilten*] world that is concerned implies that there can be no privileged access to it that preceded the division [*Teilung*], or could embrace it. It is only because of this, that a ruse is required to equip the results of experimental science with the necessary obligations, which they have gradually won, and which allows science to productively reintroduce even the misunderstood, and the merely probable, in a project of world disclosure, stretching across generations, and organised according to divisions of labour.

It is clear that the results of science themselves are not immediately available to the individual in the form of world disclosedness, and also, only as a very small part, as something in its disclosed undisclosedness. And, it is only partially compensated by the standing-availability of such technology, through which scientific knowledge is exteriorised in such a way that it does not need to be understood in order to be mobilised.

A region of science is also not demarked once and for all in opposition to non-science, through the constitution of science, as if, in a certain way, one world would be reserved for the scientific efforts at disclosure, and one for the individual, who would then be permitted to dedicate him/herself to it in a disclosing way. On the contrary: this distinction will itself be continually renewed in the eventful process of the scientific world disclosure that occurs on the boundary between science and non-science.

It is thus subject to an inevitable drift, and continually opens itself up for the new, in opposition to non-science. Even if there are as many worlds, as there are varieties of world disclosure, there are, however, not an innumerable amount of forms, but rather only two. For, if every form of world disclosure can only be directed towards one or the other side of its distinction, and this has the consequences described earlier, then there is not only no structural difference between the scientific and the individual forms of world disclosure, there *can* be none.

This is valid for exploration, targeting undisclosed regions, just as it is for the experiment: wherever space is closed by a region of increased disclosedness being divided from the world in the world, and an iteration context writes its own narrative discernible from the world, in the body where shifting boundaries undermine essential determinations, where technology loses its technical character, and becomes a mediator, where media are opaque, intentions lose their mastery, and one of the intuitions acquired in the history of this iteration context takes over the direction, and sure-footedly steers a process lacking a goal, between chaos and automatism, while upholding an indeterminacy which is sufficiently open to unforeseeable events to provide an absent other with the possibility of communication [*Mitteilung*], even if it is only of the kind which clears a place for the absence, in short: everywhere where an experimental system constitutes itself—and let it be ever so rudimentary and fleeting—there will also be experimented.

The individually oriented form of explorative world disclosure should, with respect to the tradition, be characterised as learning. Just like scientific exploration, learning is based upon a preceding distinction between the disclosed and the undisclosed. Although learning must also be considered as a paradoxical event, that can only take place on the boundary between the disclosed and the undisclosed (and

not somehow beyond that which is sensibly accessible to one, so that one can only establish what was not earlier known to one by looking back), learning is easy to understand because of its everyday familiarity: one knows what one does not know (or is told so), and then one learns this—so can one disclose a world.

In this, it is no longer noticed that this is already a clever way of managing paradoxes, in which one, instead of referring to that which is to be learnt, of which one knows nothing, refers to the term for that which is to be learnt, which one does not need to learn because one already knows it ("tomorrow we will learn analysis").[1]

Expressed in terms of form theory: the processing of the distinction between the disclosed and the undisclosed in learning directs itself towards the side of the undisclosed. However, every form of world disclosure oriented towards the individual, in which the distinction between the disclosed and the undisclosed has itself become a problem, where one does not know what it is that one must learn, to be able to track this down, so that one is given the feeling that the world is not as it is depicted to one, one must not only simply begin with what is already known, one must also bring this into focus.

Expressed in terms of form theory: the processing of the distinction between the disclosed and the undisclosed is directed towards the side of the disclosed. Drawing from the tradition, and to make the breach clear, one can name the experimental form of world disclosure oriented towards the individual *Bildung*. Just as in science, both these complementary forms, in their respective individually orientated ways, require different strategies, and must also be respectively thought differently. Consequently thought, this then also applies for every form of scientific disclosure of processes of learning and *Bildung*.

Through this division of the concepts of learning and *Bildung* into one side of the distinction between explorative and experimental thought systems, respectively, the concept of learning is no longer degraded when opposed to that of *Bildung*. On the contrary, it is revalued as a complementary concept. While, in the articulation of *Bildung* as a fundamental transformation of the figures of world and self relations, only the concept of *Bildung* is attributed with a transformation potential worth mentioning, while the concept of learning describes the form of world disclosure in which the "fundamental figures of world and self relations" remain untouched, here, the fact is emphasised that there is no form of world disclosure that can be thought without transformation.

This is because every work on the distinction between the disclosed and undisclosed itself changes the distinction (unless it is an imaginarily construed constancy via the detour of a recursive identification with the starting point only available at the end). Admittedly, it is also learning that is here grasped as the process that *is based on* a *preceding* distinction between the disclosed and undisclosed, but it is

[1] That learning is also a paradoxical event, and also that the orientation from a preceding distinction cannot cement or bridge the breach between the old and the new, also has a good side: only so, is it, for example, understandable why children, as Marja van den Heuvel-Panhuizen has shown, using the example of a bad mathematics lesson, can also learn correctly when something is incorrectly taught. (Van den Heuvel-Panhuizen 2003).

understood iteratively, as already consciously distinguished from the idea of a mere repetition, which would allow something to be added in a manner as equally static as it is seamless.

The radically new is not something that plays an exclusive role in processes of *Bildung*. Correspondingly, one should only speak of learning when one afterwards knows something that one did not know beforehand (to which, of course, can also belong afterwards knowing that one already knew—when one did not previously know *that*). That one *earlier* identifies that which is to be learnt as that which is to be learnt, and can name it accordingly ("tomorrow we begin with analysis"), still does not render this work on the distinction between the disclosed and the undisclosed a kind of zero-sum game of set theory, in which one element from one side wanders over to the other side—it is just easier to imagine it that way.

At the same time, *Bildung* is understood as a process which finds its conditions in learning, just as scientific exploration prepared the scientific experiment (without collecting, no assembling). *Bildung* can sensibly first of all begin where the possibilities of learning have been exhausted, or the idea takes form that learning according to an existent distinction between the disclosed and the undisclosed leads away from the trace of that, the communication with which, is of central concern.

That does not mean knowing everything about the world, already because of the dividedness [*Geteiltheit*] of the world; but *Bildung* is only imaginable from the background of a departmentalised part of the world in the world, the disclosedness of which is raised to its limits (thus a part, which is not simply a section of the world, but rather always an intensification of a part of the world that points beyond it). Since it concerns purposely bringing the conceivable possibilities of an unthought-of possibility to its limits, then the possibility of the failure of *Bildung* cannot be excluded, nor even mitigated. Wimmer points this out when he writes about the challenging experience of a paradox:

> The experience of the futility of the paradox, or the aporia, is the experience of the limits of the given possibilities, and the existing self and world relations. This limit does not demark the line between the realm of the possible, and the feasible, on the one side, and the realm of the impossible, and utopian, on the other side, but rather, it divides the possible itself, and from the beginning onwards. As such, one cannot be concerned with leaving it behind, or overcoming it, but it also does not mean contenting oneself with the given possibilities. (Wimmer 2006, p. 365)

This is the constitutive meaning of the experience of the paradoxical for *Bildung*. And this experience is prepared for by learning.[2] Wanting to introduce a hierarchy between learning and *Bildung*, or between exploration and experiment, so that one can be played off against the other, to speak of one merely learning, while the other is self-educated [ge*bildet*], appears from this perspective, to be not only not sensible, but rather simply absurd. Perhaps the dignity of learning can thus be

[2] Just as in the experience of impossibility, understanding that the experiment within the "limits of the given possibilities" was prepared for by the explorative thought system in that one learnt more and more about the praxis of the experiment. Steinle (2000) has shown how manifold the possibilities of experimental experience are in an especially clear and understandable account—and how insufficient the present and still dominant understanding of the experiment is.

rediscovered, instead of judging learning as being so inferior as opposed to *Bildung*, as today seems to be the case, where hardly anything appears to be leftover which does not come with a claim to "*Bildung*".

In the frequently met intellectual separation of learning facts and playfully "experimenting", as an activity that can be shown independently of these facts (cf. currently, for example, Marotzki and Jörissen 2009) is, to the contrary, essentially separating that which structurally belongs together: namely, the learning of facts viewed as secure in order to prepare for the opening of an unforeseen event in a process of *Bildung*. Here, the facts do not at all have to be scientific, they do not even have to be conscious facts, what is important is solely that they can be *assumed* as given and mobilised as such.

In other words, whoever tries to experiment *without having any idea* [*Ahnung*],[3] can, at the very most, bring about that which is commonly and mistakenly viewed as "experimental": an aimless tinkering, the foreseeable lack of results of which can, for reasons of politeness, at best be stylised as a "creative" act. A closed space brought to the limits of its disclosedness can thus only be construed by one who has learnt so much that s/he can select and assemble the heterogeneous elements in a non-accidental manner, so that s/he (without being able to guarantee success) can translate them into an iterative context (an assembly), and that without it straightaway disintegrating, or falling into the mere repetition of machinery.

This requires knowhow and familiarity in handling, up to the point of virtuosity. Thus, whoever does not know his/her way around a part of the world would do well to firstly exploratively disclose this, instead of immediately wanting to begin experimenting around, or firstly learning what there is to learn, instead of straightaway pretending to be educated [*gebildet*]. What initially appears to be a conservative argument is, at a second glance, not so—it cannot be used as legitimation to reject the new. Processes of *Bildung* are precisely not based upon a preceding distinction between the disclosed and the undisclosed, but rather themselves constitute, beyond this distinction, a division [*Teilung*] of the world that they themselves introduce, in order to intensify the disclosedness of the resulting part of the world. Because there is nothing to disclose within this part of the world according to the preceding distinction—that which probably also presents itself to outsiders as already existing—, both experimenters and those personally involved in the processes of *Bildung* inevitably behave almost deliberately ignorantly in the face of that which, according to the preceding distinction, remains to be learnt if one is to qualify oneself to communicate [*Mitteilung*].

Simply put: that the scepticism against innovation is so often accompanied by commentary from outsiders that the innovators are arrogant because they are not experts in the relevant fields, can be simply put down to the fact that the critics and the innovators are referring to respectively different "regions". At the beginning, and during a process, of experimentation or *Bildung* they would not be in the position to be able to legitimise their deliberate ignorance of what, for others, still

[3] In both senses of the word: then, as was shown above (in Sect. 3.13), those who have no idea can also not get an idea; intuition needs to be acquired.

remained to be learnt. For, guided by little else than the vague idea that that would not help track down that of which *one cannot say* what it is, they remain speechless—up to the point at which they can hear, and communicate [*mitteilen*], the communications [*Mitteilungen*] of that which was of concern the whole time.

If the trick of replacing the old, world-constituting division [*Teilung*] of the world with a new one, in which this something has the possibility to communicate [*Mitteilung*] is successful, then these critics, like Hobbes, find themselves in a world in which their distinction between the disclosed and the undisclosed suddenly no longer counts. For Stengers, this is the moment of "*the invention of the power to confer on things the power of conferring on the experimenter the power to speak in their name*" (Stengers 2000, p. 89, and also see Sect. 2.4).

That it is, in the end, surprising that the distinction between *Bildung* and learning can be almost seamlessly matched to the distinction between experiment and exploration, a distinction that has been extracted from initially more obscure works such as "Toward a History of Epistemic Things. Synthesizing Proteins in the Test Tube" is, at a second glance, less so. For, the reading matter of the research in the more contemporary studies of science and technology was never "open", and free from preconceptions, but was rather thoroughly motivated as a theory of *Bildung*, and its perspective was accordingly preformed.

In the process of the selection of that to be assembled and tuned, that which could not be completely explicated could thus act as tacit knowledge. That the experimental could be at all recognised as a strategy for creating possibilities for an absent other to communicate is, for example, only understandable against the background of Koller's suggestion of understanding *Bildung*, together with Lyotard, "as a process, in which new sentences, families of sentences and types of discourse are produced in order to hold open the conflict by helping to express an until now inarticulatable 'something'" (Koller 1999, p. 150). Precisely that which works, without thereby pressing for explication, is, just like objective technology, presupposed.

If *Bildung* is delimited from learning in such a way, that *Bildung* is described as that which leads to a fundamental transformation of the figures of world and self relations, while these figures remain untouched by learning, then that which works on a practical level is repeated on the theoretical level: the fiction of a constancy. If one opposes learning and *Bildung* to each other, in this way, then not only is the paradox of every learning process lost, but also that of the process of *Bildung*; insofar as that which has already been presented as temporally unfolded on the theoretical level, which can, *ex post*, only appear successively: the "transformation" after the "failure". Paradoxical descriptions of problems, as was already hinted at in Sect. 2.8, are therefore especially analytically fruitful, because, with their help, a problem which, in reality, is not there, can be formulated as a paradox under the abstraction of time. Without the precision of a paradoxical description of a problem that must be practically processed in the form of a Re-Entry, there exists the danger of defining on the theoretical level that which, in its non-anticipatory nature, characterises the eventfulness of a practical solution.

If a paradox is not theoretically clearly named, it does not mean that it disappears. They remain, for the most part, easily recognisable; however, they must then

be theoretically defused, or rendered invisible. This is also valid for the "transformative concept of *Bildung*". This becomes clear in, for example, Peukert, when he speaks of *Bildung* inducing experience,

> which, if we *really* allow it, explodes our previous ways of dealing with reality and our self understanding, which exceeds are processing capacities. If we *really* wish to take up such experiences then this requires a transformation of the fundamental structures of our behaviour and our self relations. (Peukert 2003, p. 10, my emphasis)

Admittedly, the fundamental paradox, shared by all processes of *Bildung*, remains clearly to be seen in this formulation—that, namely, every process of *Bildung* runs ahead of its own beginning, or, in Peukert's conceptuality: that the result of a process of *Bildung*, the transformation that enables experience, depicts its own condition, namely, the transformation inducing experience. However, the practical (and theoretically practical) challenge within this formulation is rejected immediately by the twofold "*really*".

Thereby, the uncertainty about what "really" should *really* mean might not compensate the limitations which have already taken place within the praxis anticipatory form of the processing of the paradox on the theoretical level. By rendering the experience of failure dependent upon one "really" allowing it, Peukert limits the range of the concept of *Bildung* to experiences which are, in principle, accessible. He thus excludes as a problem for *Bildung* all that which made experience an aim of the experimental process at all—which here corresponds precisely with the region reserved for the concept of *Bildung*. At the same time, he locates the condition for whether an experience can be made, or not, in the subject, which allows this, or does not allow it. The problem thus not only gains a moral hue, it disappears from view, which would be to change the claim of the other, the absence of which here threatens to remain unnoticed, namely, the material-semiotic condition of a shared [*geteilten*] world, which depicts the conditions of possibility for its communication.

In a structurally comparable manner to how Peukert here wards off the paradoxes of *Bildung*, Schäfer also wards off the paradoxes of *Bildung* in the quotation regarding the other, cited above in Sect. 3.3:

> despite all efforts, it is not possible to *completely* give up one's own, one's own patterns of order, which still have the categorisation of something other [*fremd*] available; and it is equally impossible to let that other [*Fremde*] be *completely* subsumed in the categorical appropriation." (Schäfer 2009, p. 188, my emphasis)

What, for Peukert, the word "really" is, is for Schäfer, the word "completely": as inconspicuous as these words are—they are the one's upon which the whole task of the defence against paradox rests, and which stand in the way of a temporalised understanding of *Bildung*. Here, the focus also remains upon the communicator [*Mitteilenden*], although what was concerned was focussing upon the form of the shared [*geteilten*] world as a primary problem of *Bildung*, and as the condition of possibility of communication [*Mitteilungen*].

When learning is placed in relation to *Bildung* in this fashion, so that *Bildung*, in opposition to learning, is characterised by its transformational potential, then not only is an inappropriate constancy implied in learning, but a kind of breach is

also implied in *Bildung* which, within this distorted opposition, and in a manner that is empirically difficult to qualify, must be described as "fundamental". It thus becomes almost no longer thinkable that a process of *Bildung* can begin unspectacularly, without the bang of an exploding self-understanding, and without the overwhelming experience of exceeding the capacity to process reality, and with nothing other than an idea, equally vague as it is diffuse, that is hardly to be interrogated, that "something is wrong here".

Since two individuals can never have exactly the same experience, and that the world, where, for one, it "is presented in its everyday, continuous form", for the other, it does not have to present itself in such a way at all, the world, in its dividedness [*Geteiltheit*], independently produces imbalances which can develop into occasions for *Bildung* (or else—and that is now decisive—not).

Without the reference to a problem that, in its paradoxicality, is not there in "reality", existing solutions have no chance of stepping forward in their complementarity or, more generally: in their functional equivalent. If all experience is presented as being accessible in principle, then the distinction between exploration and experiment collapses, and thus also that between learning and *Bildung*. If, at first glance, the assumption that the distinction between learning and *Bildung* is, in this complementarity, inappropriately overemphasised on the theoretical level, then, on a second glance, this complementarity reveals itself as being *empirically* the condition for being able to think the interrelations between learning and *Bildung*.

4.2 The Failure of Failure

> There are experiments with us, before we, ourselves, start to experiment.
>
> —Bernhard Waldenfels 1998, p. 241

The world alone can never force the process of *Bildung*, not even to initiate one. This does not exclude the fact that experiences stand at the beginning of a process of *Bildung*, which depict themselves as a failure, as experiences which depict themselves in such a way, as if they "would explode our previous ways of dealing with reality and our self understanding, […] exceeding our processing capacity". However, even these powerful metaphors are not able to point beyond the paradox that the result of a process of *Bildung*, the experience enabling transformation, depicts its own condition, namely, that of the transformation inducing experience—for, of course, exploded ways of dealing with reality are not capable of rendering the inexperiential experiential, and an exceeded capacity for processing cannot process that which has exceeded it.

One cannot go behind the back of the temporally (and spatially) unfolded process of *Bildung*, nor can it be reduced to the moment of failure and transformation: without thoughtfully placing oneself on the track of the absent other, and so entering a process which one neither has in the hand, nor is passively subjected

to, a "transformation" of the shared [*geteilten*] conditions for communication [*Mitteilungsbedingungen*] is unthinkable.

Thus, in the beginning, there existed a definition of situations worthy of *Bildung* as such, in which one could not advance any further with the help of previously proven figures of relations to the world and self, but rather, simply failed. However, this failure is, as was shown at the beginning, already not without requirements, but must be included in a definition of *Bildung* as a process, the beginnings of which run ahead of itself.

The world, as shared [*geteilte*], is a "space", which is always much too open to fail. It is sensibly characterised by an irreducible glut of possibilities, which is why an exclusion of options must always precede failure. Loosely put: the expectations of the world always also come with the possibility of arranging oneself with them. The possibility of arranging oneself with the way in which the world depicts itself are literally limitless, even when the inability to create possibilities for something to communicate reveals itself to be unbearable (even if it is the feeling of unbearability itself that makes communication appear impossible).

This becomes clear, at the latest, when one takes into consideration that one can always evade the claim to communication by letting the communicator disappear, whether this be an imaginary rejection, whether it be in the form of its destruction: at the latest, when destruction cannot be excluded as a possibility,[4] then there is actually a *fundamental* deficiency of lack, whereby failure is equally fundamentally nothing that one could build upon.[5]

4.3 Technological Limit Conditions

> The logos of the phenomena is never free from a simultaneous techné of the phenomena.
> —Bernhard Waldenfels 2004, p. 120

[4] Even suicide, which is erroneously seen as a failure in the world, is actually the possibility, never to be excluded, with which every failure can be brought to fail—as a permanent option of self destruction on offer: from the perspective of a theory of Bildung, accounted in terms of form theory, suicide is the final arrangement with a world in which one participated in, in which no possibility of co-mmunication is anymore envisaged, and, as a consequence of this, the attempt at doing it justice is given up. This is certainly the existential meaning of the point that every process of Bildung is overrun by its own beginnings.

[5] Also equally fundamental in this, cf. Waldenfels, who locates the starting point of technological inventions in situations, which are admittedly compelling, but must nevertheless be thought of as irreducibly open: "Becoming human [Menschwerdung] begins in a situation that extorts inventions from us, placing some of them to hand, but never forcing them. Even hunger and death, in which the field of possibilities melts down, allows for various responses. Technology equally has its place of origin here. A differential view of technology and invention, holding these contingent origins in focus, is developed from a resistance against a mechanisation which, like its anti-mechanistic rival, takes its measure from a one sided and narrow form of technology, and applies this measure." (Waldenfels 2004, p. 185).

Roswitha Lehmann-Rommel makes a further categorical distinction in her account of experimental thought in Kant and Dewey (see above p. 57), between a "technological understanding of experimental thought" (Lehmann-Rommel 2008 p. 122), and a non-technological understanding of experimental thought, whereby, for her, the latter "represents an epistemological alternative to the representational understanding of truth, according to which, knowledge is understood as the correct representation of an independent reality (adequatio rei et intellectus)" (ibid.). "All experimentation is technologically composed", says Rheinberger in unmistakeable contrast (2001, p. 153), and, indeed, the experimental, as it is here accounted for, with reference to, among others, Rheinberger, is unthinkable independently of technology.

However, because technology, in this consideration of the experimental, is nothing that can be determined essentially and independently of the process itself, one does not get very far with the conventional determinations or classifications of technology (within the experimental system of thought technology must be thought otherwise than in the explorative). What is clear, however, is that a "technological understanding of experimental thought" which is opposed by Lehmann-Rommel to a non-technological understanding, and could function as "an epistemological alternative to the representational understanding of truth", can be nothing else than a misunderstanding.

For experimental apparatus can only be "technological", in the sense of a machine-like construction, when it is no longer suitable for experimentation. The reverse, however, in the attempt to experiment without the aid of technology, can also be regarded as something that is already, from the outset, condemned to failure—for, somehow, an iterative context of heterogeneous and required elements must be held together. If one asks, within the experimental system of thought, about technology, then one cannot expect a sensible answer to the question what technology *is*. However, one can begin to trace technology if one asks regarding its function.

The function of technology results from the necessity of having to construct an experimental system in which heterogeneous elements can be brought together in an iterative context in order to form a historicised narrative—and that is already something that exceeds the performance of event based consciousness or communication. Without the aid of something which holds the heterogeneous elements together over time, and meanwhile excludes all else, the experimental system *within* which one could think, would be unthinkable.

Experimental systems can be highly volatile, and their technology can appear very non-technical. As such, reflection itself, which already carries with it a break with the linearity of time in the form of words, can only be thought within the experimental system of thought, for reflection is the simplest, and most natural (and thus seldom considered), form of experimentation (assuming, of course, that the reflection is concerned with the attempt at tracing the communication of an absent other, therefore an attempt at world disclosure; this is already the case, for example, if, after an argument, one reflects about what one has done wrong).

For Dörpinghaus, reflection appears as even the sole form of world disclosure that the individual has at its disposal, when he writes that *Bildung* can only be

thought against the background of a space of creativity which opens in the form of a reaction, "a re-flection that opens and holds open, something that would otherwise be closed without it, and which breaks through a natural order" (Dörpinghaus 2005, p. 566). When one follows *something* in thought that one does not know what it is, but one has an intuitive idea that it is not nothing, and when one attempts to trace it in thought, by *again and again* thinking a certain situation, a certain problem or, more generally, the context in which this feeling has stalked one, then falling back on filtering techniques is unavoidable.

These are not, thereby, themselves objects of thought, but rather hold together that which is to be thought in some sort of exteriorised form, and screen it against all other possible thoughts; they thus create, as a *form*, the limit conditions of thought. Thus, one applies concentration techniques *without thinking about it*, which enable one "to remain focussed on the matter at hand", *which means nothing other than* excluding the majority of thinkable thoughts, the glut of thinkable options. If one thinks, for example, about the connection between exposure to radiation and leukaemia (to recall the example from Sect. 3.17), one excludes any number of possible thoughts, e.g. the thought about the possibility that a Geiger counter perhaps does not measure radiation, while the fact that it does, as an elementary part of the form of a technological limit condition, limits the space of thinkable possibilities for the connection between exposure to radiation and leukaemia.

Thus—although not considered—the form of these elements, which creates the limit condition, is indispensable, just as a great deal of knowledge must be assumed as known knowledge in a natural science laboratory, in order to be able to work on the distinction between the disclosed and undisclosed at all. Technology is not just anything that produces something with this knowledge, but rather simply the *form* in which the elements are translated into a more or less fixed context, which constitutes the technological limit conditions of the experimental system. As soon as one doubts the existence of a Geiger counter, or its ability to measure radiation, one must remove this element from this form, and render it an epistemic object.

In the case of reflection, one must exclude almost everything as unthinkable, so that one can *simultaneously* concentrate on the essential. It almost goes without saying, that the process that one is attempting to describe, when one speaks of "concentrating on the essential", "hold a thought", "remaining with the matter at hand", "only thinking one thought at a time", or "dwelling upon a thought", because of the eventfulness of consciousness, cannot literally be understood as a "dwelling" and so on. Thoughts, as Luhmann has made very clear, are, as elements of consciousness, highly volatile states, which are already over when they have begun (Luhmann 1995). The eventfulness of a thought literally prevents it from dwelling on a thought, whereby reflection can be nothing other than an iterative process, and the metaphors of "dwelling" etc. are nothing other than indications of the successful, virtuosic mastery of the techniques of concentration.

They refer to the necessity of closing an iterative space to the chaos of the world, against the glut of all the other possible thoughts and distractions; a delimitation which itself, with this thought, cannot simultaneously be an object of thought, and must therefore be secured in some sort of technologically exteriorised, and intuitively mobilisable, form. In the simplest case, it is the body itself which, in this sense,

serves as technological medium, and in which, at the same time, the experience, the intuition acquired in the virtuosic mastery of this technology, has been sedimented.

Every reflection, therefore, necessarily refers beyond itself. With every reflection one mobilises techniques for controlling one's concentration, in order to exclude irritation from the outside world: one turns one's gaze away from those things begging for attention, or towards less irritating things, such as the ceiling of the room,[6] one falls into an intuitively manageable routine, such as pacing up and down the room, one buries one's head in one's hands, in order to reduce sensory impressions etc. One can never leave the body behind when thinking, neither in dealing with "exogenous" techniques, nor when dealing with "endogenous" techniques. And, because it is itself a source of distraction one must, in every case, bring it to itself in the form of an inner exclusion. And, even this is only possible via the exteriorising possibilities offered by technology: one must be able to fall back on the techniques of bodily mastery, in order to cope with all the irritations that enter via the senses, or come from the body itself, and threaten to collapse the reflection's iterative space.

That these are hardly recognisable as technologies, that it appears to outsiders, as if people with especially strong powers of concentration can simply cut themselves off from the world, is naturally not because someone can switch their senses on and off, but rather because of their especially virtuosic mastery of concentration techniques. The handling of these technologies must be virtuosic, so that they can be intuitively managed without them falling under the focus of attention—just as one would not get very far driving a car if changing gear had not become second nature.[7]

Waldenfels also describes this when he writes about attention: "since attention, including attention deficit disorders, is only to be thought against the background of the configuration of attention, it is realised in historically and culturally changing *attention techniques* and *attention practices*. Optical and aural training always also entail the exercising of attention." (Waldenfels 2006, p. 107) He describes the connection between various forms of technology at another point:

> The intermediate instances, which lend our own attentiveness support and form in what strikes us, can be traced back to inventions which are restricted neither to a simple discovery nor to a simple game of imagination. This is also valid for the invention of technologies which find their support not only in the materiality of things, not only in formulas and formal methods, but also in the techniques of the body. (Waldenfels 2004, p. 162)

As long as the virtuosic mastery of such attention techniques was so natural that they could be assumed as technologies and forgotten, they were not a subject—not even in pedagogy. If, however, they do become a subject, then as a problem: the exercising, the training of such techniques, to which, of course, "sitting still" also belongs, could be defamed without regard for the consequences, because the function

[6] "The economic plays an elementary and unavoidable role. The selection inhabiting all attentiveness, this simultaneous turning to and away from, renders attentiveness a scarce commodity" (Waldenfels 2006, p. 107). On this cf. also Sect. 1.5.

[7] One would need to correspondingly modify and generalise the relation between eye and hand in the natural scientific experiment depicted above for the "thought experiment": as thinking in which one can forget the body and as thinking in which one must deal with the body.

of these techniques, as long as they functioned, disappeared from sight, just as all the other techniques that function without problem.

As a condition of possibility of reflection, the mastery of these techniques must count as the concern of the pedagogue.[8] That which today easily gains attention, to which also belongs that which has been intentionally developed to gain attention, is something which, as such, necessarily stands in conflict with reflection. Stiegler points this out when he describes the special meaning of pedagogy in the exercising of attention techniques in thought and technology as the philosophy of technology, and understands this as something which is in direct competition to other "technologies for the control of attentiveness" (Stiegler 2008). In his eyes, this does not concern just another technology among others, but a struggle in which the prevalence of the psycho-technologies of stupidity (such as advertising), or of the psycho-technologies of intelligence (such as pedagogically mediated attention techniques), is at stake (cf. Stiegler 2009b).

Already, in its most volatile and everyday form (which is, however, likewise characterised by a break with the everyday), experimentation can thus only be thought when various characteristics of the experimental come together *in an assembly*: the departmentalisation and closure of a space in the world; the heightening of disclosedness, or the reduction of the interference of the world, up to the point where something can take on contour in its absence; the displacement of a movement in space, where one goes from one thing to the other, and increasingly takes more and more into consideration, to a movement in time, in which one restricts oneself, and, again and again, replays one's selection, this assembly in one's thought, guided by a suspicion that something is missing; the tinkering with the elements in the assembly, instead of trying to observe isolated elements so exactly that one discovers what one had, until now, overlooked; the necessity of mobilising technologies—it is already clear that here a task is concerned which calls for empirical investigation.

And, just as in every experimental form of world disclosure, success in reflection is also utterly dependent upon the quality of translations that are tinkered with; for, whoever reflects on the world does not, after all, have it in his/her head, but rather thoughts, which also do not mirror or represent the world, as one would have said in the context of the explorative system of thought, but rather, themselves have a completely different form to that the position of which they take on, to that which they translate, and which is replaced by them. Whoever attempts to make rhyme or reason of a text, on the basis of a bad translation, using reflection alone, or even attempts to find out what it does not take into consideration, is doomed to failure, independent of the intensity of the reflection. In this, it is immaterial whether the error is caused by the transmission of a radioactive trace by a particle detector into a table, or from one language into another via a third, or initially through one's own misinterpretation, transferring the translation into one's thought.

[8] That which for Kant self-evidently counted as the tasks of a pedagogy aimed at responsibility is now something with which to remind those who feel called by the attempt to bring discipline together with obedience, and thus play against responsibility—and which also gains attention because of the media conforming schemas of provocation requiring no reflection.

In each case, the cogitator thinks within an erroneously virtualised space—with a translation which does not possess the power and the ability to take the place of the translated, which may communicate something within it, which previously was lost in the interference of the world. The familiarity with the explorative distinction between (representative) language and (represented) world, and, with it, the familiarity with a purely linguistically understood concept of translation, make the extension of this concept of translation appear strangely artificial.

However, without its extension, one must assume an unshared and homogenous world, which is there as such, the division of which one does not participate in, and which stands opposed to oneself in such a way that one could have the idea that one could observe it, and that one believes in being able to reflect about the world from beyond it, instead of within it.

If one, against this, visualises the multiplicity of translation services which first make it possible to combine together heterogeneous elements in an iterative context, an iterative context which can only be maintained with the aid of technology, then, already in the first reflection about reflection, it becomes clear how massively reductive the translation must be, in order not to exceed the possibility of concentration techniques maintaining the cohesion of an iterative context of pure thought.

It becomes equally clear how grotesquely limited the possibilities of consciousness are, in tracking down an absent other, and how large, in comparison, the probability of its trace getting lost somewhere in the course of these multiple translation could be. Little could be changed in this without the invention of more efficient technologies (namely, only that which training in existing technologies can still bring out).

The possibilities can therefore only be significantly extended through the invention of more efficient technologies, and that means increasing them through further strategies of exteriorisation. If one wishes to move on from the rudimentary experimental system of reflection, and add complexity to the game, then one must utilise cultural technologies such as writing down, one must make writing down more efficient through the use of writing systems, one must collect the writings with the aid of organisational technologies, and be in the position to learn to think within the experimental space that is partitioned off from the world by these organisational technologies, instead of restricting oneself to the scope offered by familiar concentration techniques. This is not without consequence for that which is called thought itself. And, one can even translate this insight from Rheinberger's inspection of biology into this more general context:

> If everything depends upon the choice of 'system', the scope of the experimenter's action, the range of the questions that he can put, and the kind of answers that he can receive, then the expression 'experimental thought' can itself still be misleading. Its grammatical structure assumes 'thought' as its *genus proximum*, the specific difference of which consists in being guided by the experiment. What is up for debate, however, is exactly the opposite: a movement oriented by instrumental limit conditions *in* which reasoning is, in a certain way, dragged into the play of material entities. (Rheinberger 1992, p. 22)

4.4 The Interpretations of the World Beyond the World

Just as in theories of science the view that, beyond the medial transmission of "images" and "meanings", there is no unmediated access to the world, has both prevailed, and become increasingly radicalised, this view has also won authority in theories of *Bildung*, in which no less than the relationship to the world is concerned. In both cases, this view is so self-evident that it hardly needs to be articulated as a view.

However, nothing is gained by this view for as long as one believes that one is dealing with a *discovery*. However, it is not a matter of discovery, something that one has found, and it is also not a matter of a special problem for epistemologists. It does not in the least concern a problem that could be theoretically solved.[9] On the theoretical level, it can only be maintained as a permanently renewed and practical problem for every form of world disclosure, or else rendered invisible. Formulating this insight on the theoretical level as a paradox means theoretically saving the problem as a challenge for the praxis, as a challenge which aims for an unforeseeable result and, in the praxis of *Bildung*, is experienced as an impossibility—thus, that which Wimmer points out when he writes that the: "experience of the futility of the paradox or the aporia […] the experience of the limits of the given possibilities and the existing self and world relations" is that which "divides the possible itself and from the beginning onwards" (Wimmer 2006, p. 365).[10]

In every account of *Bildung* that has not been so paradoxically formulated that its object—the world—simultaneously serves as its goal and its starting point, the problem that the new cannot be the old must already be laid bare on the theoretical level, or have been made to disappear. The classical solution to this paradox on the theoretical level consists in dealing with the world as something external and immutable to the "subject of *Bildung*", and to oppose this with an "image" or "interpretation" of it, which, contrary to the world, in the course of the processes of *Bildung*, is seen as mutable, or even "fundamentally transformable".

The insight that the self is not transparent to itself finds its (already fairly paradoxical) expression in the turn of phrase of *Bildung* as the transformation of the relations of world *and* self. However, if grasping the world consistently as a paradox is not successful, then the interpretations of world and self will necessarily be

[9] To those who believe this belong the "constructivists" and the "realists", whose dispute won such great attention for some time: on this cf. Hacking 1999.

[10] Wimmer thus, in a certain way, sets deconstruction against the formation of theories of science and thought against theory and science: "Deconstruction, unlike theories of science, takes on another relationship to praxis, in which theory or knowledge does not have the task of ensuring its success, but rather of enabling the event. Thus Derrida does not speak of theory or of science but of thought." (Wimmer 2006, p. 371) The difference between Wimmer's discussion of the meaning of paradox in relation to theory and praxis, deconstruction and science and the arguments being followed here is small: if one understands theory as prescriptive and science as aimed at a closed theoretical context it is even extremely small. The difference consists more in a shift: in the attempt to understand the praxis of science itself as deconstructive, and to determine the task of theory therein, instead of prescribing the praxis its solutions, holding present thought's (as one that is always practical) unsolved problems.

opposed to the world and the self, as if they were not equally a part of the world as the "world" and the "self" themselves. The insight that there is no access to the "world in-itself", and that the possibilities of experience are limited, and it is just this limitation, and its distortion, which a process of *Bildung* must be concerned about, is immediately underhandedly cashed out thus: the transformations refer to the interpretations, and the world will have always been as it is represented in the transformed interpretation (if one does not wish to move to the position of the trivial constructionist, and sacrifice the division of the world by dissolving the paradox on the side of mere interpretation beyond every world).

Structurally, this corresponds precisely to the relationship between theory and empiricism developed in the theory of science, right up until falsificationism in the Vienna Circle: positive references to the world are recognised as being impossible, the experience of failure must, however, in order to avoid paradox, be thought of as being without presupposition, and thus serves as the boundless foundation of every form of thinking world disclosure.

Placing the paradox at the centre of thought does not mean merging all difference, such as that between the world and its interpretation: interpretation is, of course, something other than that which is interpreted, just as a translation is not the same as that which is translated, and a theory is not the same as that which is theorised about, and a signifier is not the same as the signified.[11] However, these distinctions do not occur in advance of the process of world disclosure, and thus, there is no interpretation of the world outside of the world, just as there is no interpretation which transforms itself, to then be proven against a world lying beyond it. It is always the world itself which is at stake in a process of *Bildung*.

Of course, not everything that happens finds itself in the focus of world disclosure: it is also played, traded, and loved in the world—*Bildung* and learning are concepts which only refer to the very specific operations of world disclosure, and not to anything else. When, however, world disclosure is concerned then it is the world at stake, and not its interpretation. The concept of *Bildung*—and, by the way, that of learning too—is not to be found anywhere beneath this. If this sounds somewhat high falutin, then the question must be asked as to what kind of foundation, or, better: whose foundation, should it be on which one can be so down to earth that one is able to maintain the world, and the distinction between it and its interpretation, steadily through a process of world disclosure.

That the interpretations of the world also still belong to the world, and that, in a process of *Bildung*, it is nothing less than the way in which a world is shared with respect to its possibilities of communication that is of concern, is to be absolutely understood as an empirical statement, and can be experienced in its simplest, and most everyday form, as the suffering of the world views of others, and those world views that one, oneself, employs about the "world", and "oneself",—these, too, provide the world with form, in which it is then commonly shared, and in which one must live with one another.

[11] For the necessity of this distinction as the condition of possibility of translation cf. Derrida 1972, p. 20.

The form of the world, understood as the distinction between the disclosed and the undisclosed, not only creates the starting point for every further process of world disclosure, but rather also determines whose communications can be heard, and whose not. That this is very much more understandable with reference to the obviously wide reaching effects of the contemporary sciences, than with reference to the individual, arises not from a structural difference—neither can science be so scientific, nor an individual so cultivated [*gebildet*] that a transcendental perspective upon the world becomes possible, in which its division is negated; both science, as well as one who is cultivating [*bildet*] him/herself, can only disclose the world by sharing it.

And, every individual thereby produces just as real effects as science, even if they are of a different scope. However, whoever has a kind of reference to one's own "relations to world and self" as if these were mere[12] interpretations of the world—has a very specific relation to the world and to oneself, namely, one that is relieved of the expectations of a shared world through an imaginary withdrawal of oneself—and thus *appears* relieved of a responsibility for the division of the world.

If one understands science only as a production facility for various interpretations of the world, and not as an instance giving form to the world, and *Bildung* only as a process of the transformation of interpretations of the world, and not as an instance giving form to the world, then it is hardly possible to think of the world as something that is actually shared in a strong sense—as something in which what matters is the communication of many. The world of an individual is just as little alone the result of individual processes of world disclosure, as the world of science is also not alone the result of a science specific "logic of research".

Naturally, science is not the product of individual performances just as, vice versa, no individual lives in the "world of science". That their margins are, however, fenced in by challenges to *Bildung* (see Sect. 3.7), and that the results of science in their multitudes of form, and their service, in obviously increasing measure, as elements of technological limit conditions for processes of individual world disclosure, brings *Bildung* and science so closely together as is at all possible in the form of a division [*Teilung*].

4.5 The Persistence of the Explorative

The experiment is described as an invention which represents a reaction to the increasing disclosedness of the world, thus a reaction to a crisis which exploration itself brought on because of its success. However, not every form of exploration has been eradicated with the disappearance of the uncharted regions on the globe, and of exploration in the form of travel. And, this is not because the shared world cannot

[12] One can twist and turn it as one will, one can hide it or programmatically claim the opposite: the "mere" has here its structural place.

be completely disclosed, but rather because experimentation, in the form of technology, has opened new territory, and new possibilities, for exploration.

However, technology does not just open up new possibilities for exploration, it represents an explorable field in itself—and this is a problem because it brings the failure of the explorative repeatedly to fail anew. All the possibilities of existing technology can never be fully explored—one does not even know all that is possible with the devices that one gave as Christmas presents to one another last year: what a lot there is of everything and what one can do with it. Dealing with technology in a way which concentrates on investigating its possibilities is explorative—even if it is only a playful, trying things out that would be commonly described as "experimental".

This is the doubled character of technology in this context: on the one hand, it is the developments in technology that act as a catalyser for the explorative, bringing it to the end of its universal scope of validity, and makes available the medial possibilities for the experiment. On the other hand, technology creates evermore possibilities for exploration, whether it be in itself, or whether it be mediated. The world, in its explorable form, thus renews itself in this fashion—according to the current state of technology.

The danger consists not in the world disappearing "behind" ever more technology, as it appears from the perspective of those who assume an ever increasing "technologisation" of the world. The danger rather consists in the failure of the explorative itself being made to fail in this way. New possibilities of exploration correspondingly undermine the necessity of placing an experimental understanding of world disclosure on the side of an explorative understanding.

Admittedly, the closure of space in the experiment leads to a situating of the experimenter, and to a break with the primacy of the visual, but does not force the understanding of his/her task as such. When, for example, at the same time, the possibilities of visualising something are apparently endlessly multiplied then the integration of the experimenter in the events can be imaginarily negated. The variety of optional points of view can then be confused with independence, and the possibility of being able to take on every point of view in principle.[13] The position of the experimenter thus becomes imaginarily transcendentally enabled (see Sect. 3.21), and the division of the world (which situates itself) is imaginarily negated.

[13] In fact, it is a doubled relation between technology and the visual: continually renewed visual technologies enable continually renewed perspectives and thus create the impression of independence. This impression can, however, only result because the visual is already correspondingly technologised—it is so accustomed to the central perspective—a representational technology, an invention of the Renaissance—that it can forget its technicity. On this cf. Giesecke 1998 and Krämer 1998, and, on the respective codification of space cf. Panofsky 1927.

4.6 Explorers and Experimenters

When experimenters believe themselves to be exploring—when they believe themselves to be observing when at work, and, in translating, describing, when they imagine themselves to be in an open space when working in closure, and hold their intuitions to be intentions, or even for rationality, when they look at the technology they are using as if it were just a tool, when they mistake their limitation for extension, when they are not aware of their intimacy with things, because they believe in their own performance of distancing etc.—, they change the world[14] without seeing themselves as being responsible for it.[15]

The impulse, almost impossible to defend against, to view this claim for responsibility as negligible, or even in conflict with the truth, is characteristic: it is a further example of the persistence of explorative thought, the alternative to mere observation "how the world is in-itself" only being recognisable in the denial, or invention, of the facts. Put more precisely: responsibility with respect to science does not lie "with the scientist", and also not "in science", but rather on the margins of science, and is based on the fact that they play a decisive part in the division of the world—which means that the margins of science are fenced in by challenges to *Bildung*.

Denying every division accompanying and exceeding science means treating the world as if it were recognisable. This is also Latour's subject, when he speaks of the "uncontrolled spread of hybrids", and argues that the belief that science only discovers facts has led to a continuation in irresponsibility,[16] which must be met with a new understanding of the relationship between science and politics (cf. Latour 2004). Haraway has concisely expressed that, in other words, the recognised world bears monsters, and brought this in relation to the primacy of the eye:

> The eyes have been used to signify a perverse capacity […] to distance the knowing subject from everybody and everything in the interests of unfettered power. The instruments of visualization in multinationalist, postmodernist culture have compounded these meanings of dis-embodiment. The visualizing technologies are without apparent limit […] Vision in this technological feast becomes unregulated gluttony; all perspective gives way to infinitely mobile vision, which no longer seems just mythically about the god-trick of seeing everything from nowhere, but to have put the myth into ordinary practice. And like the god-trick, this eye fucks the world to make techno-monsters. (Haraway 1988, p. 581)[17]

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[14] Haraway thus speaks of insight also as "materialised refiguration" (Haraway 1997a, p. 64).

[15] That scientists also have a responsibility does not mean that they can take responsibility for the results of their research. As a scientist one does not, after all, think out one's results beforehand.

[16] Cf. e.g. Latour 1993, pp. 1–12. That Latour oscillates between the realisation that we do nothing else than talk about these hybrids the whole time and deal with them on a daily basis, and the claim that we cannot even think them because of the division between fact and fabrication, is also due to him, instead of differentiating between exploration and experiment, attempting to recursively universalise the experimental back into the past: one can understand his thesis that we were never modern in exactly the same way—as the claim that the vocabulary of the explorative is not appropriate and never was.

[17] On the eye as "guardian and source of the truth" in pedagogy and its relation to the figure of the conqueror cf. Wimmer 1988, p. 275 f. Wimmer uses the example of the Pietists to explore the

That it is still normal, in every form of science, to hold the experimental for the explorative, also shapes the way in which the results of scientific work can become parts of "individual worlds". And, this general persistence of the explorative can also be accordingly strategically exploited. This understanding of science influenced by an unbroken universality of the explorative is made evident in expression such as: "science has established that…" or "X has discovered Y".

For, while communications must be communicated, the recognised can be announced. When it is a question of how an educative [*bildendes*] relationship to science could look, then the answer must begin with this distinction between communication and announcement. To illustrate using an example: perhaps because of his double role, as both businessman and as scientist, Craig Venter possesses a special antenna for the exploratively informed image of science, or the image of the scientist as a public explorer. Venter, who describes himself as one who has "revealed the book of humanity to the world" (Venter 2009, p. 469), rhetorically, and iconographically, kits himself out with numerous traits of the explorer.

These underline the impression that the human genome is something discoverable, and that he is himself the discoverer. In this form, all questions concerning the form of this research, and the questions concerning communication, are removed from the history of research itself. Questions such as: who takes part in this research, and who is excluded? How is the private sector part of the research fenced off from the public university part? Who finances what, who can profit from it, and in what manner? How are questions of property legally managed, how are objections dealt with? And finally: where, and in what manner, is the question followed up as to which communications are taken into consideration at all, which presentiments are followed up, and which not?

All these questions take on a specific form in the explorative narrative: as epistemically subordinate questions they become obstacles on the way to a discovery. And, in a certain way, and from a certain perspective, abstracted from everyday laboratory life, in this concrete case this is even a correct image, for it is the experimental work which primarily (before the establishment of the Human Genome Project) disclosed a space of undisclosedness with the genome, and thus opened it up for exploration (the history of protein synthesis in the test tube belongs to this undertaking).

And, it is now this exploration of a space already disclosed as undisclosed that is performed by Venter with a flourish. He struggles like Columbus against adversity, such as the small-mindedness of his fellow men. He holds fast, despite all hindrance, to a set goal of "decoding the human genome", repels the "political attacks" of his opponents, additionally conquers the new market, and finally discovers the book of life, and unveils it to humanity. Although this is here only roughly sketched,

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relationship between the visual and the modus of insight: "The visual must be desubjectivised and disembodied if it wishes to decipher the truth of children and separate naturalness from its perversion. Observation is performed without intervention, distanced, silent, without gesture, nothing is a secret for it. The pure gaze has the privilege of recording the invisible since it is equipped with the whole logic which distributes the visible within a given conceptual configuration. The observing gaze does not help to realise this, but rather only to recognise" (ibid.).

the effect of the explorative self presentation on corresponding expectations is still understandable.

Mass media delivers the illustrations to this sketch of exploration: one finds diverse articles about Venter, in which a picture of him taken obliquely from below illustrates him with a determined gaze directed towards a distance goal, steering his sailing yacht over the sea. The iconographical continuity with classical exploration can hardly be more clearly depicted (cf. e.g. FAZ from 12.09.09, TIME magazine from 29.04.07 and Nature 449 from 18.10.07, pp. 785–786).

The Stuttgarter Zeitung from 24.01.08 writes: "After he was no longer welcome in his own firm he began to explore the sea. He sailed around half the world chasing the genes of sea-borne microorganisms." The example would not be of further significance if it did not concern a more or less adequate depiction of science. However, with the inability to understand world disclosure otherwise than as explorative goes the inability to take an educative [*bildendes*] relationship towards it—with respect to the scientist, insofar as s/he recursively identifies the world, as the result of scientific work, with its initial situation (which is the precondition of being able to stylise oneself as a discoverer), and thus, still recursively, and in the light of the results, understands the necessary decision exceeding science, regarding which communication can be considered, and which not (the communication of the preceding division), as one which only concerns science.

And, with respect to everything else, insofar as it also touches on this, and thus every question regarding which communication should be taken into consideration in a process, and which not, is rebuffed as something which does not concern them. The division of the world as precondition for every form of experimental science is, in this form, imaginarily negated in the name of science on both sides of the distinction between science and non-science. And, this complicity in the imaginary absolving of responsibility is itself held together by the image of the experimenter as explorer.

To summarise these cursory remarks: the question regarding the relationship between *Bildung* and science is not about winning a critical distance to science's claim to validity, but rather the ability to do justice to science's claim to communication [*Mitteilung*]. This does not simply mean listening to what it has to say, but rather to grasp what is shared [*geteilt*] by it, in what form, and who, or what, does it put in the position of being able to communicate [*mitzuteilen*], or not to communicate [*mitzuteilen*].

This is not a process which only once took place with Boyle, but rather one which always takes place anew, again and again, and begins every time with the assembly of heterogeneous elements: with the assembly of such elements that can speak, and such that cannot, but nevertheless have something to communicate.

4.7 Turning to Language as Avoidance

> Language matters. Discourse matters. Culture matters. There is an important sense in which the only thing that does not seem to matter anymore is matter
>
> —Karen Barad 2003, p. 187

One of Rheinberger's significant achievements is taking Derrida seriously in his extended concept of writing, and placing deconstruction in relation to a "hard science" in such a way that the experimental event in the natural science laboratory could be recognised for what it, in its strategical and cunning way, is: namely, a form of deconstruction. In early discussions of natural science, one often, from the perspective of the humanities, restricted oneself to the attempt at deconstructing science's claim to validity. Instead of asking oneself what one could learn from it, one tried to instruct it.

Rheinberger's detailed description of an experimental process, with its consequent inclusion of the materiality of the objects, and the technological apparatus, using the example of the history of protein synthesis, allows the study of the characteristics of experimental world disclosure in this theoretically prepared example, while, at the same time, a permanent compulsion is maintained, not to leave the objects, and the technology, aside.

The experiment thus becomes recognisable as a bundle of solution strategies to such problems which, in their reconstructed form, have to be paradoxically accounted for. It is only in this paradoxical account that problems first become recognisable as being comparable to given solution strategies, or even as demonstrating structurally affinity with one another. The work of natural science thus becomes understandable as work on the boundaries of a shared world, and it also becomes possible to refer the question of *Bildung* to the same shared world, and not to the other half of one previously divided according to its areas of validity.

Thus, what is problematic in the current understanding of the concept of *Bildung*, with its unserious consideration of technology, is not really its consequent consideration of the irreducibility of the semiotic condition of the world in the course of the "linguistic turn", but rather the inconsequence with which the insight that "There is nothing outside of the text" (Derrida 1997/1967, p. 158) is cashed out. In earlier texts, I have tried to show that one can distinguish between two fundamentally different ways of "turning to language" in the theory and research of science: firstly, in the theory of science in the tradition of the Vienna Circle, which is characterised by its delimitation from positivism, and is here reconstructed as a theory of the crisis of the explorative, and which can be represented by the name Popper, and, secondly, the "Lwówian tradition" begun by Fleck, which, from the beginning on, placed the experiment at the centre of attention, as the insight generating centre of research.

As a specialist in typhus working experimentally, Fleck did not first have to discover this—his achievement consisted of not only gaining biological insight from the experimental praxis, but also insights into the study of science itself (instead of a day job in biology, and, after work, changing to the theory of science). Rheinberger is here placed at the other end of this "Lwówian tradition".

I tried to show, using the examples of Peukert and Euler, who both explicitly refer to theories of science in the tradition of the Vienna Circle, that as long as *Bildung* cannot be "thought in concrete relation to the subject area of natural science and physical technologies" (Ahrens 2005, p. 102), how "*Bildung* is accounted for in the sense of an innovative speech event, such as in the philosophy of science of the 'Viennese tradition' where linguistic innovation had been previously described as material innovation." (ibid.). This could be clarified, and generalised, with the aid of the distinction between exploration and experiment, within the scope of this work.

Now, it is, namely, no longer a question of how one includes the "subject area of natural science" and "physical technologies" in the thought of *Bildung*, but rather of thinking *Bildung* itself. The criticism of the turn of language, which, at the same time, depicts avoidance, is thus no longer limited to the texts of authors such as Peukert or Euler, who explicitly try to include natural science and technology in the thought of *Bildung*, but also includes such theoretical texts of *Bildung*, in which natural science and technology are not spoken of.

This is what makes such a criticism of this kind of turning toward language, which, at the same time, depicts avoidance, problematic and simultaneously difficult to demonstrate. For, that which is of concern here, is not in some way falsely depicted, but is rather absent. It can, however, be intuited that something is missing, e.g. then, when one wonders that C. P. Snow's thesis from 1964 entitled "Two Cultures" still appears plausible, or that so little is said about technology when it is so obviously significant for the "relations of world and self" of everybody.

What, for the philosophy of science, is the "crisis of representation" is, for the theory of *Bildung*, in a certain way, the "crisis of the transcendental subject". In both cases, the turn towards language is motivated by avoidance: primarily directed against positivism, on the one side, and, primarily against the idea of a transcendentally thought subject in the middle of the world-disclosive event, on the other side. Both forms of turning towards language present, against the background of the distinction chosen here between exploration and experiment, two different attempts at freeing oneself from the explorative, without being able to—in the absence of an alternative system of thought—actually separate oneself.

If *Bildung* is nothing other than the experimental form of world disclosure as applied to the individual, then it is this itself which cannot be thought within explorative thinking—and, even then when this thinking exhausts itself on that which, in the explorative, has become problematic and implausible. The turn towards language thus still remains bound to the idea of an opposing world in the avoidance of the representation. One emphasises, in delimitation to positivism, or in delimitation to the idea of the transcendental subject, that one cannot think beyond language, but is forced to think in these terms, for want of a paradoxical account of the world. This would have enabled the confrontation of two systems of thought, yet it still spoke as something opposed to the world and was thus necessarily reduced, often in the narrow, linguistic sense. In a discourse in which the completion of the "linguistic turn" represented the successful evasion of overcoming ideas of thought, everyone who supposed, in reverse, a linguistic limitation, ran the danger of being thought of as being backward looking. For example, Karen Barad almost inevitably provoked just such reactions when she wrote:

> Language had been granted too much power. The linguistic turn, the semiotic turn, the interpretative turn, the cultural turn: it seems that at every turn lately every 'thing'—even materiality—is turned into a matter of language or some other form of cultural representation. (Barad 2003, p. 187)

In the averting turn, one can immunise oneself against criticism, on the one side of the coin, by pointing out the "breadth" of one's own concept of language, which always meaningfully includes what was criticised as being excluded. And, one can, simultaneously, show oneself to be pragmatic, on the other side of the coin, by determining the limits of one's concept of language exactly insofar as one's own methodological and theoretical possibilities allow.

So, just as one is suspected of positivism in the philosophy of science, when one holds this form of the "linguistic turn" to be inappropriately reductive, one also runs the danger, in the discourse of the theory of *Bildung*, of being suspected of reintroducing the transcendental subject when one holds this turn towards language for a problematic reduction. However, in the light of the distinction between experiment and exploration, the corresponding distinction between *Bildung* and learning, and with the help of a paradoxically composed concept of the world as being shared [*geteilter*], this suspicion can be assuaged as being unfounded.

If Lüders correctly describes the current situation of the theory of *Bildung*—and this is what I assume—then this is influenced by the "linguistic turn" in exactly the form in which the turn towards is motivated by avoidance:

> A further tendency of the conception of the subject in contemporary theories of *Bildung* results from the so-called linguistic turn of the cultural and social sciences. The slogan of the 'linguistic turn' means the increased 'reflection of the semiotic mediation of all knowledge and finally all operations of consciousness'. (Lüders 2007, p. 34, cited from Peukert 1998, p. 23)

In the following, Lüders expands upon how this turn to language also concerns the turning away from a metaphysical concept of the subject:

> This means, in relation to the possibility of knowledge, that the consciousness of an individual subject is no longer its starting point, 'but rather it is much more the power of language, or every linguistic procedure which first constitutes the world and self relations of subjects'. Here, a concept of the subject is criticised which is based upon the antecedence and interiority of subjects: the cogito is no longer the central starting point of a consciousness, which is formed externally to language and is only (later) represented through the act of language. Subjects are much rather the effect of such procedures of language, insofar as these first produce all possibilities of thought and articulation. Accordingly, every self determination of the subject is fundamentally linguistic or semiotic. (Lüders 2007, p. 34, cited from Koller 2004, p. 190)

That here, a narrowing of the concept of language is concerned, is already signalled by the "or" in the "linguistic *or* semiotic" turn. This signal becomes even more clear in that, for Lüders, this turn explains "the orientation towards aesthetic in pedagogy since the mid 1980s" (Ehrenspeck 2001, p. 148, cited from Lüders 2007, p. 35): "For, where are the processes of (semiotic) reinvention or prescience more likely to be found, than in literature, the representative and performing arts or music?" (Ibid.). If one distances oneself from the anthropocentric reduction of the concept of language to such statements, the research of which falls in the area of "linguistics",

then the question as to where the (semiotic) processes of reinvention or prescience are *more likely* to be found than in literature, the representative and performing arts, or music, can, no doubt, not be directly answered. One can, however, say where the processes of (material-semiotic) reinvention can *also* be found: in the laboratories of the biologists and the chemists, in the cafés where programmers write blogging software, in the craftsman's handling of his materials, the architect in the building of her models, the breeder in dealing with his dogs, the doctor in discussing her patient's liver, and the social scientist's handling of his notes.

In fact, none of these activities takes place beyond a meaningful, semiotically composed structure of meaning. Who today would want to claim otherwise? And processes of innovative reinvention certainly take place in the praxis of these activities. However, one must also assume that these were not *first* linguistically-theoretically *forethought* in literature, performance or representative art, in music, or in pure theory, and *then* materially-practically implemented. Lüders once again writes "or" ("For, where are the processes of (semiotic) reinvention *or* prescience more likely to be found, than in literature, the representative and performing arts, or music?"), and thus places the "processes of (semiotic) reinvention" on the same level with the "processes of prescience".

This is structurally the same form of pre- and post- organisation that Popper argued for with his idea of the precedence of the theoretician over the experiment. However, this post-organisation is also accompanied by the post-organisation of technology itself, which thus gets lost from sight in the very process, and together with it, the fact, theoretically crucial for *Bildung*, that it, just like language, determines the boundaries of our thought, and thus of our world.[18] If here, following a suggestion by Haraway, the talk is of the material-semiotic composition of the world, then this is in order to emphasise the necessary connection between materiality and the sign in the production of meaning, but delimited from a concept of the semiotic that has been too narrowly understood.

Translated into the conceptuality chosen here this means: it also concerns the consideration of the communication of those who do not speak our language. That no sign can produce meaningful effects if it does not attain some kind of material form, is just as little a new theoretical insight as the view that nothing that meets us in this world exists before every meaning, and every sense, and thus every form of insight, are semiotically composed. And, in this respect, the turn from the "materially-semiotic" composition is simply in the service of a delimiting emphasis.

The hyphen indicating the togetherness of material and semiotic thus only has insightful value in the light of a turn towards language, in which human language is both understood as irreducible, while at the same time being opposed to the world, and in which the communication of non-human beings (Latour) can go

[18] Also see Koller's arguments as to why he holds Popper's concept of falsification for less enlightening of the Bildung's theoretical question as to the origin of the new: "For Popper's Falsificationism delivers nothing other than a formulation of a philosophy of science which […] was described as occasion for a process of Bildung: the failure of a previously valid or 'successful' world and self understanding in the confrontation with new experiences or problems." (Koller 2007, p. 53 f., my emphasis).

unappreciated, just as the role of technology is unappreciated when it is represented as being subsidiary to language. However, if one does not think of technology as an equally irreducible part of a process of *Bildung*, one also loses from view the praxis of dealing with it, and thus the history that this praxis inscribes in the body.

However, in a world which one shares with all sorts of things and non-human beings, this is crucial, for *Bildung* too, is concerned with the form of this shared world. Embedded in a harmonious social scientific context according to C. P. Snow's "Two Cultures", this *Bildung's* theoretical connection does not necessarily have to be apparent. And, because of this, too, natural science was the focus of concern: in the hope that it, in this way, will prove itself to be an Archimedean point for the theory of *Bildung*, as it proved itself to be an Archimedean point for Latour, through which it was possible to lever sociology out of its forgetfulness of technology.

Lüders account of the contemporary situation of the theory of *Bildung* is helpful here because, by reconstructing the "dimensions" of the concept of *Bildung* in a clear and systematic fashion, she makes visible that which otherwise only seldom gains contour. Normally, the absence of technology is simply lost—in the statements written about *Bildung*, and in which there is only silence regarding technology. Only occasionally, when the "world of science" or technology becomes a subject of discussion, does the suspicion arise that something is still missing.

Now, at the end of this work, this suspicion articulated at the beginning hardens, that it is not just chance when Dörpinghaus uses the example of Heisenberg to illustrate a process of *Bildung* in physics, whose viva voce examiner, Wilhelm Wien, not only certified his "bottomless ignorance" of experimental physics, but also seriously claimed that the "starting point for the development of his theory" could be traced back to his reading of Plato's Timaeus. Or when he, in his search for "occasions of deferment" significant for *Bildung*, in which he looks through the classical culture program, with reading and writing, the consideration of art, the game of debate and show, but, at the same time, is suddenly silent regarding profane technology, about which he *was previously concerned the whole time*.

Perhaps one can stipulate the following as an intermediate result: if it is about the goal of thinking *Bildung* and natural science together, then the theory of *Bildung* is on the right course when it succeeds in talking about physics without, instead, talking about one of Plato's dialogues. And, if it is about the goal of thinking *Bildung* and technology together, then it is first on the right course when it succeeds in talking about technology without, instead, talking about literature, painting, and music.

The insight into the necessary semiotic composition of the world should be reckoned against the determination of the world as the unity of the distinction between the disclosed and undisclosed. The insight that this world is not the world in-itself, should be reckoned against its paradoxical determination and the necessity of the Re-Entry. The insight that the world is variously depicted from various perspectives, although it is always about various perspectives of only one world, should be reckoned against the determination of the world as shared.

However, the goal was also the delimitation against the anthropocentric primacy of human language, as opposed to all other forms of communication. Within this, firstly, also expressed is the insight that we are not alone in the world, but rather

share it with others, and partly with *totally* others. And, secondly, expressed therein is the insight that this fact is something which we cannot disregard, even if we are not interested in the rest of the world. For, whoever can communicate to others how, is still, and perhaps even more so, dependent upon conditions which are decisively influenced by the development of technology and natural science.[19]

4.8 The Empiricism of an Experimental Theory of Bildung

It can now be *stipulated* that *Bildung* is not merely "a theoretical construction that possesses no reified equivalent in empirical reality and can only be disclosed indirectly, in the manner of an interpretative reading of empirical facts"—"however one might wish to define the concept" (Koller 1999, p. 161). As an individually oriented form of world disclosure *Bildung* indeed possesses no "reified equivalent to empirical reality", just as, equally, there is nothing thought within an experimental system of thought that can be meaningfully considered as its reified equivalent in empirical reality.

This does not, however, mean that it is simply a theoretical construction—on the contrary: *Bildung* is here assigned the whole of the empirical claim which one can assign a *factum* within the experimental system of thought—no less than the Phlogiston before Lavoisier, and no less than oxidation after Lavoisier, and more than a *Bildung* which is understood as the transformative speech event as a result of the failure of figures of world and self relations.[20]

Therefore, if one does not exploratively limit the task of theory to the description of empirically understandable facts, then the relation of the theory of *Bildung* to the praxis of *Bildung*, and the relation of the theory of *Bildung* to empiricism can, in this light, be grasped otherwise: the theory of *Bildung* cannot catch up with the praxis of *Bildung*. However, what it can do, in contrast to praxis, is to relocate the problem for which the praxis has always already found a solution. And, it is only so, through the detour of theory, that the contingency of present solutions first becomes at all recognisable, and thus comparable, with other possible solutions.

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[19] It is for this reason that Latour's efforts around a new sociology (cf. esp. Latour 2005) are so important: what concerns him is the necessity of establishing a systematic place for natural science in political discourse—not in order to attack its claim to validity, and also not in order to come to an agreement beyond alleged cultural differences.

[20] It also brings—as perhaps will now become clear—theoretical-practical advantages with it when one considers the relationship between theory and practice in its dependence upon the respective system of thought and not, for example, as a representational problem. In other words: the relationship between theory and praxis is not a derivative problem of the problem of representation—rather, both problems are bound together in the interconnection and in the complentarity of both systems of thought (or, if one so will, in connection with their "incommensurability"); Michael Lynch is correct when he writes with an eye to the attention afforded the problem of representation: "Representation is overrated" (1994, esp. p. 148)—for the problem of representation is also not one that can be approached independently from the composite of one of the two systems of thought.

Thus, the theory of *Bildung* is also only possible in the light of a break with the given time of "the chain of events and actions" (Vogl 2007, p. 48) and is, to a certain extent, the hobby horse of a professional procrastinator. The openness of this outline of the concept of *Bildung* is not striven for as the result of an attempt at integrating the non-anticipatory new that characterises *Bildung* in an "indeterminately" held determination of *Bildung*, but rather as the result that *Bildung* is paradoxically determined. *Bildung* thus remains on the side of its practical realisation, open to the event (to a certain extent, maximally indeterminate), while, on the theoretical level, the contingency of *this* paradoxical account is emphasised (to a certain extent, maximally determined).

That *Bildung* is determined as a paradoxical work on the distinction between the disclosed and the undisclosed in its individually oriented form on the side of disclosedness is a decision. However, this decision should be rendered plausible through opposing the various characteristics—to a certain extent, *bottom up* instead of *top down*—and legitimised according to their usefulness for subsequent work.

This legitimation must, therefore, take place retroactively, from the future; it cannot be preventively delivered through reference to the past. These, and accompanying conceptual decisions, are also rhetorically highlighted by means of pointed emphasis and contrast, and, for this reason, should be maintained as transparent decisions. One can term this approach essayistic if one, as Max Bense suggests, understands the essay as an experimental form of writing (Bense 1969), and "experimental" in the sense depicted here. For, if one understands *Bildung* as an experimental form of world disclosure then nothing remains one, except to also approach the disclosure of processes of *Bildung* experimentally.

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