Experimenting with the Concept of Experiment

Probing the Epochal Break

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For a couple of years now a chorus of rather cacophonic voices has been heralding the fact that over the past few decades science has undergone a profound transformation. This has been answered by another chorus, more precise and concordant, that there has been no such transformation—at least no break or sharp discontinuity—and that the existing, commonly accepted vocabulary is sufficiently apt to describe recent developments in science and society. Beyond the parameters of this so far indissoluble antinomy, several voices have been attempting to overcome this dualistic formation. In this chapter we focus on one such position that offers a specific mode of analysis for identifying such a transformation, for "seeing" an epochal break. Our intention in using this term is not to question whether or not knowledge-production as a whole has changed over the past few decades. Instead, we adopt the position that it is rather a question of finding the right vantage point—that is, "the proper distance to scientific practice"—of making a case rather than settling a fact (see Alfred Nordmann's chapter in this volume). Such a vantage point enables us both to make visible and to appreciate the changes that might turn out to be important and illuminating in better understanding the forces and powers governing relationships between science, technology, and society.

Our focus is on observing changes in the practices of science-based experimentation in society. We suggest that there has been a major shift from the *laboratory ideal* to the *field ideal* of experimentation. The laboratory ideal involves designing manipulated, well-controlled, isolated experimental systems; the field ideal acknowledges their complexity, blurred boundaries, and unpredictable response to interventions. Field experiments could hardly be called an alternative ideal if they had not undergone a reevaluation in the philosophy of science and a reassessment with regard to their social relevance. We suggest that both changes can be observed especially well in the 1980s in the domain of the environmental sciences. Even if field experiments were not entirely new at that time, environmental concerns in science and society gave them a new cognitive status, institutional backing, and a specific rhetorical image. Today we are seeing the spread of new styles of experimentation to many areas of society. Experiments performed in *open spaces* might be, say, a social reform or a medical treatment, an ecological remediation or a technological innovation. A number of concepts are in circulation that seek to label these various experimental constellations, including real-life or real-world experiments, experimental installations or innovations, adaptive or experimental management, and prototyping. For the sake of conceptual clarity, we have decided to use "field experiment" as a generic term.[1]

The dynamic interaction between research activities and innovation strategies forms an important feature of what is widely known as the knowledge society. One of its outstanding features is the continuous shifting of knowledge-production into contexts of application and a concomitant increase in research in the applied sciences. This trend not only signals the growing relevance of applied knowledge in all domains of society; it also implies the extension of research practices to sites outside the institutional framework of science. Furthermore, if research—both basic and applied—comprises experimentation, then clearly experimental activities can be expected increasingly to pervade every field of innovation in society. In the process the institutional rationality of science that welcomes errors and failures as vehicles for augmenting and substantiating knowledge is transferred to society, at least to some degree. Society in turn confronts science with new responsibilities regarding the risks associated with research in the open spaces of societal change.

Scholars of the philosophy of science have generally paid little attention to these changes. A brief glance at recent literature may help to position our argument. Martin Carrier proposes an "interactive view" of the relationship between science and technology. He argues: "For letting this potential of reciprocal stimulation unfold[, it is essential] to leave room or leisure for hooking up the practical goals with the theoretical framework" (Carrier 2007). This evokes a concept of research that comes close to the Baconian notion of the ideal mode of interaction between science and society: maintaining an awareness of epistemic challenges as they emerge alongside societal needs and ensuring that they are reflected in practical research goals. We will return to the Baconian conception in a moment, but let us first hear another voice. In his 1997 book *Pasteur's Quadrant*, Donald Stokes argues against a linear, unidirectional model of knowledge-production and transfer from basic-pure science to applied science and technology. Instead, he suggests that technological advances can also lead to a deeper understanding of a particular theory. He puts forward a four-field scheme based on the parameters of "understanding" and "control," resulting in four different research modes that are all equally present in the world of knowledge-production. One such research mode—"Pasteur's Quadrant"—stands for use-inspired basic research, and it is this approach on which the author focuses especially and toward which his sympathies are clearly directed, given that Stokes has chosen it as the title of his book. Although researchers in this quadrant are fully aware of the potential real-world utility of their work, they never lose sight completely of their desire to advance scientific understanding as well. *Pasteur's Quadrant* calls to mind the Baconian ideal—an impression strongly supported when it comes to Stokes's ideal of a symbiotic relationship between science and government in the service of human welfare (figure 10.1).

However, we do not believe that the Baconian ideal of relating science to society—the so-called Baconian contract—is capable of addressing the spread of scientific practices into innovative fields of society. Instead, we are heading toward a new knowledge-society contract, which on the one hand turns society into a research field and open laboratory and on the other binds experimental practices and hypothetical reasoning to the conditionality of social acceptance.

Figure 10.1. **Field site at the Center of Advanced Studies (Zentrum für interdisziplinäre Forschung, ZiF) in Bielefeld, Germany.** Studies about the invasive species *Heracleum mantegazzianum*. Photo courtesy of Astrid Schwarz, June 2007.

We regard this shift from the Baconian to the knowledge-society contract as the pivotal point of the epochal break.

So are we really heading toward a new knowledge-society contract? It could well be argued that the features of field experimentation are not entirely new. Indeed, history abounds with examples from medical research, weapons testing, schooling and learning, colonialism, and the chemical industry (to name just a few) where human beings have been unduly exposed to strategies of trial and error. This kind of "science in the making" has been observed in authoritarian as well as democratic societies. However, in only a few cases have those concerned and the general public been properly informed—let alone invited to participate actively. Usually, the experimental design involved was both secretive and sloppy. Given this backdrop, this kind of experimentation stands on ethically and politically slippery ground. In line with the self-image of science, however, historical cases of problematic field experimentation are seen merely as blots on an otherwise unblemished landscape of laboratory research. If it is true that scientific research is increasingly becoming an agent of change, then new forms of legitimacy, information, and participation are needed that can be readily interpreted as giving rise to a new knowledge-society contract.

1. Philosophy's Blind Spot Regarding Experimentation

Experimentation became a focus of interest for philosophers of science from the 1980s on, when they began to pay attention to the role of scientific practices in knowledge building rather than dealing solely with theories and purely logical operations.[2] A whole range of new research questions arose as a result, giving rise to the new research field of experimentalization.[3] Since then, it has become commonly accepted that there is more to experimentation than just the testing of theories. There is now notably less agreement around the question of how experiments address theories and even less about whether theory always plays a role in experimental practice.[4] Nonetheless, these activities aimed at revisiting the role of scientific experimentation ("the new experimentalism") rarely touched on the field ideal of experimental practice. One reason for this may be that the field ideal is even more of a pluralistic concept than the laboratory ideal. It can be located in such diverse disciplines as psychology, sociology, geology, and economics. However, there has been no broader systematic attempt to date by the history and philosophy of science community to compare and scrutinize these different approaches.

Despite this rather unsatisfactory epistemological situation, we have identified an important locus of theoretical activity that crystallized in the

1980s and was prompted by the environmental movement. One move that brought about profound change—namely, the search for a different cognitive structure of scientific knowledge—was the call for ecology to be an "alternative" or "soft" science.[5] Another was the growing awareness of the social and political context of knowledge-production. "There is a social interest at stake not only in the utilization of scientific knowledge but also in its production" (Böhme 1979, 105). A research group comprising philosophers and sociologists made its main concern the analysis of "alternatives" produced by science that were later "filtered out" by dominant societal interests. One of the outcomes to emerge from this project in the 1970s was that ecology was now regarded as a scientific field of knowledge-production that might enable us to understand ourselves not only as a product but also as an agent of nature. The frequent reference to "society as a laboratory" captures quite well the ongoing transformations that coalesced around a concept of experiment that we have called the "field ideal."[6]

Perhaps the most striking feature of field experiments is that they deal with objects "outside," in an uncontrolled environment. Further important features in the field include individuality, uniqueness, contingency, instability, and also potentially lack of safety. This kind of conceptualization clearly establishes a distinction between the individualizing, value-laden understanding of field objects and that of lab objects as instances of generalizable knowledge. However, laboratory practice is no substitute for field experiments: "unforeseen difficulties are found only in pilot experiments conducted under field conditions."[7] It is the field ideal of experimentation along with its historical, epistemic, and rhetorical tradition that becomes the dominant framework within which scientific findings and technological innovations in our knowledge society are first tested and then eventually applied. The knowledge society itself—and not the controlled spaces of a laboratory, a museum, a court, or a theater—is the stage upon which experimental design must prove itself.

2. Historical Flashback: The Baconian Contract

It was not until the late seventeenth century, after the founding of the new academies and societies of modern science, that the laboratory ideal of experimentation was codified. Its central dogma is that scientific experimentation—whether it results in success or failure—cannot cause harm to society as long as it is performed within the walls of these institutions. These walls facilitate an unlimited search for facts and the construction of artifacts for the purposes of expanding and testing the knowledge base of science. In this sense the meaning of "walls" can be taken quite literally. Taken metaphorically, they hint at a structural analogy between the methodological isolation of experimental systems within their natural environments and the ideological isolation of experimental activities within their social environments. However, as a new style of innovative practice, the experimental spirit was not created within "walls" but spread out into many fields of late Renaissance society. Artists, engineers, instrument makers, surgeons, and other practitioners developed new attitudes toward understanding nature's inventions, designing machinery, and exploring the globe.

Francis Bacon gave a variety of names to this new form of intellectual activity: "experimental philosophy," "scientia operativa," and "inquisition of nature." He also articulated what came to be called the "Baconian contract" between modern science and society. If the normative structure of society is prepared to permit all kinds of investigation into the causal structure of nature—the nature of human beings and society included—then science is prepared to pass back potentially useful knowledge and technology to all spheres of society. Bacon's lifelong (albeit unsuccessful) efforts to gain political support for organizing experimental research on a large scale caused him to ponder the question, What kind of institutional setting would convince society of its benefits? Because the promise of gains cannot be justified by an anticipatory form of argument, he suggested in *Novum Organum* that balancing social costs and benefits was a matter of risk and trust: "For there is no comparison between that which we may lose by not trying and by not succeeding; since by not trying we throw away the chance of an immense good; by not succeeding we only incur the loss of a little human labor. . . . It appears to me . . . that there is hope enough . . . not only to make a bold man try [ad experiendum], but also to make a sober-minded and wise man believe" (Bacon 1860 [1962], book 1, aphorism 114).

This assessment of the risks associated with the political authorization of the experimental method was based on an important normative claim concerning the relationship between science and society—namely, experimental failures as well as errors of hypothetical reasoning are acceptable because they affect only the internal discourse of science, not its social environment. Mistakes in the laboratory can easily be corrected, and society is only affected in terms of its choice of options from among those offered by approved scientific knowledge. These conditions applied to experimental science have served as the backbone of the dominant ideology that supports scientific progress, making scientific research and technological invention key features of the process of organizing and modernizing society and its institutions. The Baconian conception of experimental science became the foundational element in the contract between science and society (Gibbons et al. 1994; and Schäfer 1999) and between society and nature (Serres 2000).

3. Laboratories as a Strategy for Generating Failure without Failing

Laboratories are protected spaces. Their isolation serves to reproduce, standardize, and generalize experimental findings. Stripped of contextual complexity and environmental variation, they are breeding zones for strange, unforeseen, and unapproved knowledge, skills, and techniques. In a metaphorical sense the isolated laboratory is also a precautionary principle that protects society from experimental failures and errors of hypothetical reasoning. The laboratory is the only place in society where failures and errors are welcomed, respected, and even morally valorized. In any case, so the reasoning goes, society is free—and has the responsibility—either to adopt and apply scientific knowledge or else to reject it.

As the dominant mode of legitimizing scientific research, the Baconian contract prevailed throughout the nineteenth and most of the twentieth century. It remains powerful even today. However, during the course of the mutual development of science and society, experimentation became a polymorphous concept and its social relations multiplied. On the one hand, the ideal of laboratory experimentation became more rigid in terms of reproducibility and precision as well as in its function to serve theory formation. On the other hand, it was modified as it spread to include all kinds of objects—nonliving and living, psychological and social, natural and technical, simple and complex, constant and changing, very small and very large, frequent and unique, within well-defined and ill-defined boundaries, with well-controlled parameters and uncontrolled field conditions. In the industrialization process of the nineteenth century, scientific experimentation became linked with experimental practices of innovation in various societal sectors, such as in agriculture (testing Liebig's artificial fertilizers) and in the health sector (e.g., in the vaccination campaigns of Pasteur and Koch).

Ecological field experiments also contributed to a shifting of the boundary: at the beginning of the twentieth century, entire lakes were used to perform experiments aimed at finding out more about the lacustrine nutrient cycle. The Schleinsee, a small lake in southern Germany, became a famous experimental system, enabling some of the most important issues concerning the complex phosphate cycle to be clarified.[8] For this purpose the whole lake was artificially fertilized with phosphates. Today this experiment would be designed to include many more actors, such as conservationists, residents, water sports enthusiasts, anglers, and—if we are prepared to include Latour's nonhuman agents—ducks and water fleas, among others. It would probably be rejected on legal, political, and ethical grounds.

Even if historical justice demands that we pay attention to these varied modes of scientific experimentation performed in open fields, laboratory experimentation has remained the ideal type of knowledge acquisition. This is especially true of all research activities and new technologies that imply risks to life and health. However, it was illusionary from the beginning to set limits to the spread of theoretical ideas that might imply risks for minds and morals. As the most prominent example—Darwinian evolutionary theory—shows, ethical neutrality and acknowledgment of error do not count for much on either the proponents' or the opponents' side when strange and novel ideas become issues of public discourse. Indeed, the principle of freedom of opinion in democratic societies ensures—with a decreasing number of exceptions—that scholars can make public and even argue forcibly for the application of theories that are still in the making. The premature testing of half-baked theories has been a frequent feature of this trend. More seriously, science and technology-based attempts to participate actively in modernizing society have become more and more successful and have left traces in many arenas. And yet the legitimacy of these attempts was largely provided and protected by the Baconian contract, whose elasticity is gradually being stretched to the point of exhaustion. A new formula capable of handling the interaction between research and innovation is called for—and is even being practiced in certain fields. Talk of an epochal break should not be mistaken as signifying a sudden change of structure but rather seen as offering a new semantics for an ongoing process of change.

4. Social Experiments with Society

Even this semantics has its precursors. John Dewey (1929, 133) was a prominent proponent of the idea that experimental knowledge-production and social change are interwoven: "The ultimate objects of science," he wrote, "are guided processes of change," and truths are "processes of change so directed that they achieve an intended consummation." Certainty in knowledge follows from achieving reliability in action. Even more radical is the notion of societal experimentation developed by the Chicago school of sociology. Albion Small (1921, 187) held the view that the rapid change of modern settlements in itself provides a "world of experimentation open to the observation of social science. The radical difference is that the laboratory scientists can arrange their own experiments while we social scientists for the most part have our experiments arranged for us."

Small located the idea of experimentation in social life and not in the scientific method. This notion of experimentation became influential in American sociology. After World War II, Karl Popper—struggling with totalitarian political experiments—suggested "piecemeal social engineering" as a way to introduce scientific method into politics. In 1969, Donald Campbell wrote the influential article "Reforms as Experiments." He developed a methodology comprising political planning and scientific design of social experiments. Although objections have been raised regarding the technocratic attitude of these approaches (i.e., that reforms were imposed more or less coercively on people), they have been influential in more recent attempts in which those affected have been turned into participant observers. These various new approaches and concepts can, with hindsight, be seen as foreshadowing the search for a new contract between science and society. But they can be seen neither epistemologically nor politically as a coherent line of development.

5. Scientific Experiments in Society

We now return to our main point, the epistemological shift from laboratory to field experimentation. The differences can either be emphasized by contrasting ideal cases or they can be interpolated by pointing at cases in which aspects of both are combined. We will give a rather rough-and-ready outline of the ideal-types and then focus on the "dappled world" of field experiments, which offer features of both. Field sciences search for and find their objects "outside," in an uncontrolled environment. Nevertheless, they also perform experiments, and these experiments are necessary; they cannot be replaced by laboratory practice. Selecting, reading, modifying, and comparing places are essential elements of field practice. Natural places are not just neutral stages on which scientific activities are played out, as labs are; rather, they are themselves objects of study. Plants and animals and, of course, human agents are not more or less passive "guests." The field experiment is based on a different material setting and metaphysical understanding than the lab experiment.

However, perhaps the most important feature is that field experiments are done in and with particular and variable places, and that each of these places is the result of a particular and unique history. Historian Robert Kohler (2002, 6) has described the field sciences as being mainly practices of place: "Field biologists use places actively in their work as tools; they do not just work *in* a place, as lab biologists do, but *on* it. Places are as much the object of their works as the creatures that live in them." To sum up, we might say that the field ideal of experimentation is oriented toward a practice of place, where spatial openness, individuality and uniqueness, instability and contingency are the dominant features. Unsurprisingly, this stands in sharp contrast to the conceptualization of the laboratory ideal, which is characterized by isolation, intervention, and completeness (Carrier 2006, 21).

We next present three types of experiments, each of them characterized by a different constellation of field and lab elements. On the one hand, the three types give an idea of the wide range of possibilities for recombining the features of the field and the lab ideal. On the other hand, they help clarify—systematically though not historically—the argument we have put forward about the shift in the concept of experiment. We start with an example of a lab situation aimed explicitly at simulating the field—not digitally with computer technology, but using an extracted segment of the "real" situation, which is why we call it real-world simulation. In the second example we learn something about nature's experiment, probably the most pure design of a field experiment. Then we turn to a case where scientific research is itself becoming an agent of change in society, thereby giving rise to a new knowledge-society contract—an epochal break.

5.1. Tank in the Lab, the Real-World Simulation

The Max Planck Institute for Limnology in Plön (northern Germany) had installed two so-called plankton towers in its laboratory—"pillars to science" as they called them.[9] The plankton towers were two steel pipes 12 meters in height and 85 centimeters in diameter, filled with around 10,000 cubic meters of lake water. Every 50 centimeters the column was equipped with a set of sensors for measuring and controlling temperature, pH, and light in situ. Interventions in these water packages were possible by injecting chemicals or algae and by extracting "lake water." In this comprehensively controlled water column, experiments were performed either with particular plankton species or with plankton communities. The institute's website stated programmatically that the plankton towers are intended to fill the gap between lab experiments and field experiments. At the same time, researchers state that this is also a source of the problem they face when attempting to transfer the facts discovered in the towers to the field situation in the lake.

What we learn from this case, which is oriented more toward the lab than the field, is that it is precisely the elements of instability and contingency that make it necessary to control the environmental conditions as well as to control the space to perform these experiments. At the same time, these experiments gain their epistemic value precisely because they are related to the field in this way—even if the character of this relationship cannot be fully understood. Karin Knorr-Cetina (1999) speaks of a gap that will never disappear completely even if the laboratory allows for an improvement (in the sense of better understanding

		Interest in application	
		No	Yes
Seeking Basic Understanding	Yes	"Bohr" pure basic research	"Pasteur" use-inspired basic research
	No	?	"Edison" pure applied research

Figure 10.2. **Four-field schema in *Pasteur's Quadrant*.** *Source*: Stokes 1997.

and control) in the relationship between the natural and the social order. One might say that this kind of laboratory experiment constructs and simulates the phenomenon whereas field experiments construe and prompt the emergence of something rather more unruly than a "phenomenon" (figure 10.2).

5.2. Invasive Environment and Species—Nature's Experiment

A red- and white-striped ribbon is all that protects this scientific object—a group of plants, the species *Heracleum mantegazzianum*—from its invasive environment in the grounds of the Center of Advanced Studies (Zentrum für interdisziplinäre Forschung, ZiF) in Bielefeld. The milieu of the plants is dominated by wind and precipitation events and disturbed by curious deer, humans, falling branches, and in some cases aggressive conservationists waging a struggle against this alien species. In addition to the perceived "invasiveness" emanating from their surroundings, these objects themselves are seen as being "invasive."[10] These species are so-called alien species and are identified with the problem of biological invasions, which has attracted increasing attention in ecological investigations. The resulting literature is impressive, as is the variety of statements made to explain why this research is important. The following quotation from the Web site of the Institute of Ecosystem Biology at the University Bielefeld is representative of such statements: "Biological invasions represent great natural experiments for the ecologist whose investigation is extremely valuable for the understanding of population spread and community- and landscape-level processes affecting the patterns and abundance of species at large spatial and temporal scales, i.e. scales which are otherwise hardly accessible for experimental ecologists."[11] This strip of meadow with the invasive plants is a virtually uncontrolled place where (most) instabilities and contingencies are welcomed because they are the objects of scientific investigation. The special quality of the experiment consists in the minimal invasiveness of the experimenter, which enables the agency of nature to come to the fore.

5.3. Piloting Innovation in Society

The restoration of a lake is a typical innovation experiment. A detailed reconstruction of the restoration of Lake Sempach in Switzerland showed how the specific conditions of a lake point to the necessity to study its individuality in the context of a real-world experiment (Groß, Hoffmann-Reim, and Krohn 2005). Still, scientists expect that despite this individuality, the results might in some respects be generalizable and transferable to other restoration projects. Consequently, the knowledge acquired in such projects often results in a form of expertise where experience gathered by observing particular cases merges with scientific background knowledge. Generally, these kinds of experiments are performed in the context of innovation projects. They are supported by the idea that social and technological innovation not only call for scientific experimentation to be extended outside the laboratory, but also that all relevant aspects of society and nature become involved. The restrictive and protected closed space of the laboratory is left behind. Instead, experimental devices are brought "outdoors." Test stations, prototypes, pilot installations, ecological restoration projects, test releases of drugs, pedagogical reform projects, town district developments, and so on expose scientific knowledge to unrestricted reality conditions. At the same time, projects of this kind demand planning, monitoring, data processing, and interpretation. Features of this type of experimentation aim at identifying and taming surprises, which would rarely appear in the laboratory world. Innovation experiments intend "to turn the relationship between action and surprise into an experimental design" (Krohn and van den Daele 1998, 195).

6. Epochal Break Seen through the Lens of the "Experiment" Concept

The importance of science in society derives not only from its ever increasing contribution of knowledge but is based above all on the transfer of experimental practices to the design, monitoring, and evaluation of innovation processes. The search for new sources of energy is a good example. The development of potential scenarios is unavoidably based on assumptions regarding energy resources, new technologies, and consumer life styles that are in turn heavily dependent on recent scientific knowledge or even hypothetical reasoning. Thus decisions based on scenarios necessarily contain experimental elements. Monitoring and feedback mechanisms determine the development of novel strategies that are either reinforced by success or weakened by surprise. Even if there is an element of path-dependent lock-in arising from heavy investments in, say, nuclear power plants, coal strip mining, or off-shore wind parks, the respective economic, ecological, and political cost-benefit ratio informs future decisions. The formation of new political institutions under the impact of experimental research strategies is still in its initial stage. It seems that politics itself is changing as it acquires a more experimental style that—with respect to the European Union—is variously called "experimentalist governance," "regulatory experimentalism," or "collective experimentation" (Sabel and Zeitlin 2007; Yuval and Lezaun 2006; and Felt and Wynne 2007). These moves to embrace new innovation strategies indicate that the revision of the Baconian contract toward a knowledge-society contract is under way.

Our vision of an epochal break advances a rather modest view with respect to fundamental cognitive shifts. It emphasizes the opportunities and politics of experimental practices. We are well aware of the conflict between the steadily growing number of more or less explicit projects of field experimentation on the one hand and the precarious disclaimer of social acceptance and institutional responsibility on the other. Thus the knowledge society finds itself in a paradoxical state: the more it absorbs scientific knowledge, the more it is compelled to deal with nonknowledge and its variants (ambiguity, ambivalence, indeterminacy). If experimentation is a privileged way out of this dilemma, the institutional tools for political use need to be further developed. Politics is bound to the rhetoric of right and wrong, and public opinion is strongly oriented toward preventing and avoiding risks. An experimental attitude, however, requires hypothetical reasoning and runs the risk of failure. Unlike the warnings heralded by the advocates of the risk society, where failures are seen mainly as malfunctions of the system, the knowledge society conceives failures as constructive components of learning.

Certainly there are cases where this kind of learning does not seem to be very clever or even appears cynical (society as a population of guinea pigs). Anthropogenic climate change would have been a case in point if it had been planned as a global experiment. Today juridical norms set limits to experimenting with uninformed people. Ethical norms should prevent the burden of risks being shifted onto future generations. However, in most innovative technological fields such as nano-, eco-, or biotechnologies, human-machine communication, medical research, energy transformation, and conservation, we are witnessing a merging of experimental application and basic research. This is the arena where an institutional and conceptual framework is needed to provide a proper conceptualization of field experimentation comprising epistemic norms, political guidelines, and policy procedures. Experimental governance would include making explicit the experimental design, establishing monitoring and data processing, keeping the public informed, and negotiating with concerned people and interest groups or, even better, enabling them to participate.

Whether these conditions slow down or accelerate innovation strategies is hard to predict. In Bacon's day it quickly became clear that the Baconian contract not only gives science its indispensable, independent, and uncontrolled space but also fulfills the expectations of the contractual parties with respect to the added value of "fruits of knowledge." In our own times the epochal break is defined, first by the (still precarious) acceptance of science as an agent of societal change that turns (parts of) science into field experimentation, and second by growing demands for public engagement to shape and control knowledge-production to turn (parts of) science into a democratic endeavor. Obviously the new contract between science and society is being forged in an experimental mode.

NOTES

1. We are fully aware of the disciplinary use of the concept of "field experiment" in social anthropology or ecology, for example (Groß, Hoffmann-Riem, and Krohn 2005, 16). At the same time, our suggestion to use "field experiment" in a broader and rather more systematic sense is supported by other initiatives, such as the Network for the History and Sociology of Fieldwork and Scientific Expeditions (see http://www.fieldstudies.dk/).
2. Ian Hacking's *Representing and Intervening* (1983) is seen as the first and most influential book pointing to the proper life of experiments.
3. K. A. Appiah noted at his presidential address of the APA Eastern Division: "The recent return to these shores of the epithet 'experimental philosophy' is—as one tendency in our profession might put it—a return of the repressed."
4. See also in Heidelberger and Steinle 1998.
5. This purported option is clearly rejected as a nonoption in the article by Jaqueline Cramer and Wolfgang van den Daele (1985). They point out that scientific ecology can plead just as little for avoiding the reductionist path as physics can. They propose instead a bifurcation of ecology: the scientific and the technological path. Only this latter one, the technological path, allows for what they call normative natural knowledge.
6. This is the title of an article by Wolfgang Krohn and Johannes Weyer, first published in German in 1989 (and in English in 1994).
7. From aquatic ecologist Walter Geller in his abstract for the ZiF workshop "From Lab to Field: Transforming Research Practices," Bielefeld, Germany, July 7, 2007.
8. See, for instance, Einsele 1936—one of the first articles in a series.

9. The institute was renamed MPI for Evolutionary Biology in March 2007.
10. They are not part of the native flora but come from abroad and spread in their new environment.
11. See "Population Biology of Alien Invasive Plants," online at http://www.uni-bielefeld.de/biologie/Oekosystembiologie/doc/oeko25.html.

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