

# The Shape of Experiment

What is the result of recent studies on the history of experiment? How has our image of science been changed since Ian Hacking's statement, "experimentation has a life of its own," turned into a catch phrase for investigations into the history of science? What is the lesson to be drawn from the studies following Steven Shapin's and Simon Schaffer's *Leviathan and the Air Pump* (1985) and Peter Galison's *How Experiments End* (1987)?

In trying to answer these questions, this conference will not aim at contributing to a more developed philosophy of scientific experimentation, nor will it try to return to the grand narratives on the history of science. Rather, the goal of this conference is to identify characteristic configurations within the history of experimentalization from 1800 to the present. The guiding question is: what are the typical forms of experiment that emerged in the separated and shared history of science, technology, and the arts?

## *Background.*

Over the last ten to fifteen years, numerous historical and sociological studies were published focussing on experiment and experimentation. Taking single laboratories or experimental set-ups as exemplary cases, these studies have investigated primarily the "material culture" of experimentation. They have shown that experiments consist mainly of instruments and tools standing or lying on the table of a scientist. At the same time, emphasis was placed on model organisms, technological infrastructures, and laboratory architectures. Furthermore, procedures for registering and computing data as well as interactions with scientific colleagues, engineers, and students were analyzed as components of the material culture of experiment.

Focussing on the materiality of scientific practice has led historians to contextualize experiments in novel ways. In particular, scholars have stressed the connection between single experimental set-ups and larger systems of communication and transport. Thus, single laboratories were situated in the dense context of urban landscapes. Cities' infrastructures

facilitated certain kinds of experiments while confronting their conduction with sometimes surprising sources of disturbance (noise, vibrations, etc.). In a similar way, the role of computers and computer net works has been highlighted with respect to the emergence of transdisciplinary areas of research (e.g., cybernetics, bioinformatics).

Recent studies of the history of experiment have also opened new perspectives for the “aesthetics of experimentation.” As it turned out, 19<sup>th</sup>-century experimenters produced and controlled the precision of their scientific work at least in part by the individuality of their gestures. The growing interest in processes of producing written and drawn representations of experimental data has also led to a renewed interest in the history of artistic and literary experimentation. Experiments did not just yield specific genres of scientific publication (the “preliminary report,” the “abstract”). At the same time they gave birth to specific iconographies dominated by the attempt to visualize the invisible, the unknown, and the new.

One might say that, in a first step, the reinforced interest in the materiality of experiment fostered the elaboration of case studies in the history and sociology of science. Today, questions emerge as to the more general aspects of these studies. There seems to be a lack of something like *a historical and comparative morphology of experiment* taking into account the important results of case studies and the same time transcending their limited points of view. We are thus driven to circumscribe characteristic configurations in the history of experimentalization, not least for the purpose of orienting future studies in the field.

#### *The “material logic” of experiment.*

Terminologically, one often distinguishes between “demonstration experiment”, “research experiment” (as a means for testing hypotheses), “self experiment,” “thought experiment”, “test,” etc. Concerning the various types of experimentation, Mirko Grmek has suggested the following scheme with respect to the history of the life sciences: 1) undisturbed experimental trials; 2) analogous and/or elementary qualitative experimentation; 3) quantitative experimentation; 4) scientific empiricism; 5) systematic experimentation. In a different perspective, the “modern” kind of experimentation has been contrasted with “post-modern” forms of experiment. The former, it is argued, relied on clear-cut separations between laboratory and society, facts and values, nature and culture. In contrast, the latter manifests itself as a “socio-technological experiment” (Latour) with no boundaries, “carried out in real time and in the scale of 1:1”, thus retrospectively changing our perspective on the seemingly modern form of experiment.

Such distinctions of terminological, systematic, and chronological aspects concerning experiment and experimentation are certainly helpful. But often they keep a marked distance from the materiality of experimental set-ups. How about taking materiality itself as a guide for discerning the shape of experiments? Take an example. On a laboratory bench a chronoscope, a fall apparatus, a telegraph key and a rheoscope gather as an assemblage as it was used to measure reaction times in human beings in the late 19<sup>th</sup> century. If one covered this assemblage with a blanket, the contour of a three dimensional body became visible. One may assume that such bodies emerged in the history of experimental sciences in great numbers. In fact, every research field – be it physiology, chemistry, or molecular biology – contributed to it. As a consequence, the shape of experiments depended on the skeletal and muscular systems of such bodies (instruments etc.) as well as on their systems of vessels (e.g. cables, tubes).

However, the question is whether or not the visual contour of such bodies suffices to grasp the shape of experiments. One might argue that experiments often include components that do not show up on the laboratory bench (such as energy sources, human observers, etc.), or that they are so flat that their exterior form is rather unspectacular (protocols, notes). In addition one could point out that forms are not just located on the level of visible bodies, but depend on networks of differences preceding visibility as such, as George Spencer Brown has suggested.

Experiments typically isolate, dissect, and disconnect phenomena and processes conceived of as “natural” in order to re-combine, associate, and vary these phenomena and processes. Single components of experimental set-ups become miniaturized and/or comprised, while others are extended and enlarged. Some processes undergo experimental acceleration, whereas others are subjected to deceleration. Is it possible to extract from such conjunctions and disjunctions specific kinds of “experimental syntheses” dominating the history of scientific practice over the past 200 years? Can we derive from historically specific associations of the heterogeneous something like a “material logic” of scientific facts?

### *Organizing experimentation.*

Laboratories are often described as factories. Recent studies on the history of experimentalization in the 19<sup>th</sup> and 20<sup>th</sup> centuries suggest that during this period a transition took place leading from single, manufacture-like experiments to massive, factory-like experimentation. In the 1840s, Berlin physiologist Emil Du Bois-Reymond conducted his pioneering trials on animal electricity in his own apartment. Du Bois-Reymond’s goal was to

carry out such experiments in larger scope. After many struggles with the Prussian administration, this led eventually to the construction the Berlin Institute for Physiology. This “factory” realized the much-desired extension of research activities, but at the same time broke with some of Du Bois-Reymond’s ideals concerning experimentation. Instead of contributing to the formation of holistically cultivated researchers, the fully developed physiology plant merely produced scientific facts “by the dozen.” This, however, did not prevent the Berlin Institute from quickly acquiring the status of a model institution having a huge impact on the construction of other such sites, including, e.g., Pavlov’s reflexological laboratory.

Besides the factory, Foucault’s “panopticon” has been highlighted as another dominant form of scientific knowledge production, although in a slightly different context. The scientific practices dominating a late 19<sup>th</sup>-century observatory were marked by a disciplinary regime by means of which the interaction between astronomers, assistants, and instruments could be organized in such a way that mutual exchangeability of human observers was guaranteed. As Schaffer has suggested, this form of organization can be considered as a “panoptical regime:” astronomical observers were directed to follow a strict practice of seeing, resulting in a situation where the observers themselves would no longer have to be observed. One may assume that collective research practices in laboratories are to be regarded in a similar way: as a disciplinary regime that adapted human beings and other organisms to technological contrivances so that even the problems of adaptation became epistemologically relevant.

One wonders, however, about the exact results of inscribing the history of experiment and laboratory into the grand narratives of industrialization and disciplining. On the one hand, connections are established with the more general topics of these developments (economy, power, techniques of the body etc.). But what are the consequences for these topics? On the other hand, the rapid synthesis with the history of industrialization and disciplining tends to threaten the specificity of scientific activities. Is a laboratory really nothing else than a factory, a panoptical regime?

#### *The experimental production of form.*

Experiments produce specific forms of time. Their components mutually interact according to specific time relations. In fact, laboratories can be seen as arcades traversed by energy sources, human beings, model organisms, data sheets, notes, and protocols combining with one another and then separating in order to gather again in different ways. The question as to

what guarantees from within the cohesion of the heterogeneous components of an experiment thus leads to the problem of experimental temporality: the development of experimental set-ups, their series and sequences, the combination of repetition and difference.

In art history in particular, the problem of form has become linked to the problem of time. Understanding form as a dynamical organization resulting from mutual reactions between living bodies and their surroundings, Henri Focillon has highlighted the temporality of form with respect to artistic experiments. According to Focillon, forms in art result from experiments in which certain rules are followed and reasoning is combined with inference. Pointing to the famous example of gothic cathedrals, Focillon explains that their forms imply a specific kind of knowledge. Following Focillon, George Kubler has suggested conceiving of all man-made forms – sculptures, tools, or writing – as *aesthetic* forms and deciphering these forms in view of their specific temporality. To represent them, Kubler looks for and at series and sequences resulting from groupings of things and problems, implying that things are materialized attempts to solve problems. Here, another question emerges. The “shape of time” (Kubler) is not immediately given in the things themselves, but results from the work of the historian. The series and sequences into which he or she groups the forms of things and problems retrospectively alter the arrangements of things that were hitherto accepted. As a consequence, the historian changes even the forms themselves. Against this background, the history of experimentation might be read as a succession of shapes, the production of which sets in motion a cascade of retroactive re-shapings.

This historiographical reflection sheds some light on the history of scientific experimentation. When, in his investigations into physiological acoustics, Hermann von Helmholtz discovers a kind of tacit knowledge about hearing embedded or embodied in musical instruments, he is confronted with the experimental development of shapes. And it is not merely the history of instrument manufacture as an experimental practice that enters into play here. One might also refer to the experimental activities of Ernst Florens Friedrich Chladni, in which acoustical research combined with the construction of instruments. At the same time, forms of visualization – the famous Chladni sound figures – connected with forms of musical instruments, in so far as their construction and investigation was directed and supported by these figures. In other words, when Helmholtz started to explicate the tacit knowledge of musical practice, he re-wrote the history of music as a history of experimentation. But how far did this impact on his own experimental practice as a physiologist? And how did Helmholtz’s research retrospectively change the grouping of scientific and artistic things? More generally: what are the consequences resulting from the

forms of art as emerging from experimentation with respect to the shape of scientific experiments?

Perhaps even the development of information technologies is to be understood in a similar sense: as in-formation or formatting that retrospectively changed the grouping of scientific *and* artistic things. Is the development of the personal computer as a particular form to be described as a result of experimentation? Or is this form not as stable as it often appears to be? Have the corresponding experiments not yet come to an end? In any case, when a recent journal for “unusual sound sources” chooses “Experimental Music Instruments” as its title, this choice is not so much to be understood as the last chapter in the history of experimentation in instrument construction as its re-opening. Today, the explicit conception of art as experiment inserts itself into the interface between art, science, and technology that is currently known under the name of “Information Arts” (Stephen Wilson).

To sum up, one could say that the history of experimentation is to be written as a history of permanent re-shapings: this concerns the question of experimental set-ups and their development as well as the problem of representational modes (images, texts, etc.) that interact with the shape of experiments. What relation does the history of scientific experimentation entertain with experiments? What are the experiments of representation in history of science, and what are the experimental shapes of this discipline?]