New experimentalism in design research
Characteristics and interferences of experiments in science, the arts, and in design research
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Abstract

Commonly the term "experiment" is in the first place associated with science, systematic methods and strict principles for the sake of knowledge creation. Nonetheless, the term is widely used across the boundaries of science. The arts attribute artworks likewise as experimental – a usage that is often claimed to be metaphorical, since experiments in the arts (including design) lack the essential attributes that define a scientific experiment.

Currently, research in the fields of science studies and literary science has revised these established conceptions as well as the primacy of the scientific experiment. The philosophical approach of new experimentalism relativizes the deductive conception of hypothesis-testing experiments and argues for a broader view. Studies in literary science and cross-disciplinary comparison between the arts reveal an age-long experimental tradition and also common characteristics of experimental work in these fields. Awareness of these developments is essential for design researchers, theoreticians and historians in order to position, theorize and argue for design experiments accordingly.
The essay suggests avoiding a narrow, one-sided view of experiments in design and design research and points to the potential of (so-called) practice-led design research to reconcile the "two cultures" that shape the field.

Introduction
The term 'experiment' is closely connected with scientific research in the natural sciences, psychology, social sciences and also archaeology. Physics, a prototypical science, can look back to a long history of successful experimentation that reaches back as far as to the scientific revolution in the course of the 17th century. However, experimentalism is also routed in the arts: Artistic experiments can be found in literature, theatre, film, music, fine arts, and design. Clearly, the "two cultures" (Snow, 1964) claim likewise that they conduct experiments, proceed in an experimental manner or produce experimental artefacts. Nonetheless a comparison between the experimental practices and results of the "two cultures" show profound differences. At first glance, there might even be more differences than there are communalities.
Differences and blurred borders can also be found when we examine experiments in design practice and in practice-led design research[1]. In both fields the term "experiment" was and still is often used but poorly defined or interpreted. The multiple uses of the term and its different meanings and connotations in the various fields bear closer examination.
In order to shed light on this subject this paper chooses an approach from the perspective of the science studies and literary science. During the last decades these disciplines have compiled an extensive body of knowledge about experiments, the interplay between experimental practice, construction of theory and instrument making, characteristics and validity of experiments in the various fields and, last but not least,

the social and material contexts of experiments (Kuhn, 1976; Schmidt, 1978; Gombrich, 1980; Hacking, 1983; Rheinberger, 1997; Berg, 2009; Gamper, Wernli & Zimmer, 2009 2010, 2011; Kreuzer, 2012).

The paper first, examines the etymological origin of the term "experiment" and early experimental practices in the Renaissance. Second, it describes characteristics and antagonistic conceptions of the experiment in science, i.e. the inductive approach and the deductive approach. Third, the so-called *new experimentalism* will be introduced, a philosophical approach that reconciles and broadens these traditional concepts. Then traits of experiments in the arts (including design) will be introduced and compared to the characteristics of scientific experiments. Next, four examples of experiments in design research will are presented and discussed within the framework of new experimentalism. Finally, the different findings and lines of argument will be brought together and conclusions drawn.

Origins of the experiment and early experimental practices

According to the Merriam-Webster Online Dictionary the English term "experiment" (2014a) originates from the Latin word *experimentum;* the first known use goes back to the 14th century. It is defined as 1a: "test", "trial"; 1b: "a tentative procedure of policy"; and 1c: "an operation or procedure carried out under controlled conditions in order to discover an unknown effect or law, to test or establish a hypothesis, or to illustrate a known law". Further, the dictionary states that the terms; "essay", "experimentation", "test", and "trial" are related to "experiment".

The German digital etymological dictionary, edited by the Berlin-Brandenburg Academy of Sciences and the Humanities, lists the term 'experiment' (2014b) in the following ways; "(scientific) trial"; "in the 16th century in medical records 'approved medicine' and 'trial', at the end of the 17th century 'trial' in the context of experimental physics".

In early usage, the meaning of the term experiment was somewhat vague and all embracing: "Test" and "trial" don't address a specific field of research and application or a certain procedure. It seems that this usage corresponded to the state of science and the arts at that time. Philosophical, scientific and artistic aspects or approaches were not yet separated from each other, as the experimental practices by polymath Leonardo da Vinci (1452-1519) demonstrate. Without a doubt Leonardo was in Renaissance one of the first major experimenters, a man ahead of his time. He conducted countless scientific studies in various disciplines including anatomy, optics and mechanics. Kemp (1981) and Letze & Buchsteiner (1999) stressed that Leonardo placed great value on "impression", "experience" and on experiments. For the documentation of the results of his empiric research Leonardo used the 'artistic' medium of drawing. (Fig.1)

Figure 1: Leonardo da Vinci: *The Vitruvian Man*, drawing, pen, ink, watercolour and metalpoint on paper, 1492. (Source: Wikimedia Commons)

Taking up a dispute between Kuhn (1969) and Hafner (1969) on the relationship between science and art in general and the role and importance of scientific and artistic pictures in particular, the question of significance arises. Are the 'scientific' drawings nothing more than a means to an end? Is the new knowledge in any case more important than the drawings? Or are the scientific insights and the drawings generated by the researcher equally important? In the case of Leonardo the question is rather pointless since there is no reason for giving one or the other part of his work greater weight. The experimental practice resulted both in scientific insight *and* in artwork. The anatomical studies generated knowledge about the structure of the human body and enabled him to draw and paint lifelike representations of people.

The "two cultures"
Subsequently, in the course of the 17th century and beyond, philosophers and scientists as well as men of letters and artists started using the term "experiment" in the context of their studies. Unlike the Renaissance scientist-artists, their studies contributed either to natural philosophy or science on one hand or to the arts on the other – even if their ambitions might have been more universal.

By way of example, the painter John Constable (1776-1837) is well known for his cloud paintings. (Fig. 2) In 1836, he argued in a lecture, held at the invitation of the Royal Institute, that painting is a science and should be undertaken in order to research the laws of nature: "Why isn't it possible to consider landscape painting as a branch of natural philosophy and the paintings as corresponding experiments?" (Gombrich, 1984[2]) He may have held the hope that his sky paintings would contribute to meteorological research and weather forecasting. But whereas in the Renaissance drawings of anatomy and central perspective added to the body of scientific knowledge, Constable's sky paintings failed to contribute by induction to meteorology (ibd., p. 227). The divide between the "two cultures" took place.
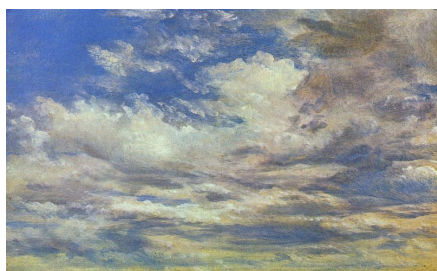

Figure 2: John Constable: *Cloud painting*, oil on paper, 1821. (Source: The Yorck Project: 10.000 Meisterwerke der Malerei. Distributed by DIRECTMEDIA Publishing GmbH)

Experiments in science
Generally, the term "experiment" is closely connected with the scientific endeavours that began at the end of the 16th century. Indeed, the exact sciences emerged in step with experimental procedures in the modern scholarly sense. The driving force was the desire to explore and reveal the fundamental laws of nature. Francis Bacon (1561-1626) was notably the first to argue that observation is not enough, but one must `twist the lion's tail´, i.e. intervene in nature, in order to learn its secrets. According to him knowledge of general principles and causal relationships results from unbiased observation, experimenting, accumulating data and setting up generalisations based on these data. His approach was known as inductive reasoning and the contemporary

philosopher and physicist Galileo Galilei (1564-1642) strengthened this tradition as did the originator of classical mechanics Isaac Newton (1642-1726) and the philosopher John Stuart Mill (1806-1873) (Heidelberger, 2007, p. 159).

In the 19th and 20th century, various natural scientists, historians of science and philosophers such as Justus von Liebig (1803-1875), Pierre Duhem (1861-1916), Karl Popper (1902-1994), and Thomas Kuhn (1922-1996) vehemently refuted the English tradition of inductive reasoning. (Ibd., p. 160f) The chemist Liebig for instance claimed: "Experiment is only an aid to thought [...] the thought must always and necessarily precede it if it is to have any meaning. [...] An experiment not preceded by theory, i.e. by an idea, bears the same relation to scientific research as a child's rattle does to music" (Hacking, 1983, p. 153).

Referring to Newton's laws of universal mutual gravitation and Ampère's theory of electromagnetism, Duhem proved that these laws and theories, which claimed to be prime examples of induction, were by no means a derivation from observed facts. Instead of this, the raw facts of experimentation had to be reframed and shaped in a symbolic form by means of arbitrary hypotheses. According to him, observation has to be interpreted within a theoretical framework in order to be useable in physics. Thus, the necessity to express the experimental data in a symbolic manner disables the inductive method (Heidelberger, 2007, p. 160). During the ensuing period, his arguments were influential. Karl Popper, an "extreme anti-inductivist", continued this approach. From his point of view, theory based on hypotheses comes first and the central aim of conducting an experiment is to eliminate unfounded hypotheses (ibd., p. 162). Until the 1970s, the discourse on experiment was dominated by an overly theoretical approach and the primacy of theory was taken for granted.

Apart from the controversy regarding inductive and deductive reasoning there is a consensus that the main objective of experiments is to gain new knowledge or to eliminate false hypotheses about fundamental laws of nature. For this purpose experiments might serve as exploration, verification, explanation, proof or demonstration of natural phenomena. This demands an objective, unbiased approach and repeatability of the experiment. The aim is to gain deep understanding of a phenomenon within a set of boundary conditions in order to be able to explain a phenomenon and to make predictions, which derive from the postulated hypotheses or laws.

New experimentalism

Ian Hacking deserves the credit for having redirected the discourse on the experiment by criticising the primacy of theory and emphasising the importance of the material dimension, experience and skill. Thus, his work (Hacking, 1983) is regarded as a "pioneering work in the new experimentalism" (Chalmers, 2008). Choosing historical experiments from various natural sciences (optics, thermodynamics, solid state physics, and radioastronomy) as case studies, Hacking provided evidence that it is a mistake to view experiment as a simple controversy between advocators of the inductive and the deductive approaches. He revealed the relationship between experiment and theory to be manifold and claimed "any one-sided view of experiment is certainly wrong" (Hacking, 1983, p. 166). Suggesting that there are various approaches, he advances this classification: "Some profound experimental work is generated entirely by theory. Some great theories spring from pre-theoretical experiment. Some theories languish for lack of mesh with the real word, while some experimental phenomena sit idle for lack of theory" (ibd., p. 159).

Beside exploratory experiments, where observation or action is undertaken to find out what will happen, and hypothesis- or theory-testing experiments, where hypothesis or theory precede the experiment, Hacking also identified 'happy meetings', where experiment and construction of theory are undertaken independently of each other but meet in the end. Furthermore he even considers trial and error and invention to be preliminary stages of the experimental method as, in some cases, they are followed by theory. For instance, the science of thermodynamics or rather the thermodynamic cycle, established by Nicolas Sadi Carnot in 1823, arose from a profound analysis of the principles of high-pressure steam engines, which had their origins in the inventions of Watt, dating back to 1767-84, and Trevithick, dating back to 1798. This example shows that the time that elapsed between action or invention on the one hand and understanding of the phenomenon and construction of theory on the other might be many decades. Hacking conceded: "I make no claim that experimental work could exist independently of theory. That would be the blind work of those whom Bacon mocked as 'mere empirics'. It remains the case, however, that much truly fundamental research precedes any relevant theory whatsoever" (Hacking, 1983, p. 158).

A further argument put forward by Hacking is remarkable. He claims, "a chief role for experiment is the creation of phenomena" (ibd., p. 220) that "did not hitherto exist in a pure state in the universe" (ibd., xiii). Herein he opposes the traditional opinion that "the phenomena revealed in the laboratory are part of God's handiwork, waiting to be discovered" (ibd., p. 225) by the observer and the experimenter. Taking the Hall effect[3] as an example, Hacking pointed out that the apparatus needed to produce the effect was man-made and the inventions were created. Thus, even though the effect is based on a fundamental law of nature, "the effect does not exist outside of certain kinds of apparatus" (ibd., p. 226).

Experiments in the arts: using the example of literature

Artistic artefacts and performances – whether from the field of literature, theatre, film, music, fine arts, or design – are often described as being "experimental". In the context of these genres, the term "experiment" connotes that the artwork shows traits such as being "novel/ innovative", "courageous" and "non-compliant", that it "opens new dimensions and insights" or that the artist "works with an uncertain outcome" (Schmidt, 1978, p. 9). A dictionary on arts, architecture, fine arts, applied arts, design, and art theory pointed to "practical implementation and testing of new procedures", "novel, daring expressions, forms and compositions", "neglecting the risk of failure" and furthermore "development of numerous new media, materials, techniques, social visions, iconographical motifs and forms" (Olbrich, 1989, p. 404). And a dictionary on German literary studies states: "Generally, in literature the term 'experimental' connotes an explorative, testing, unusual approach" (Jäger, as cited in Berg, 2009, p. 53).

Consequently it has been argued, that in the field of the arts the term is mostly used metaphorically, since the artistic experiment can be characterized by absence of all the essential attributes that define a scientific experiment. For instance, artistic experiments lack a theoretical framework, a systematic method or methodological approach and the possibility of verification through repetition. Furthermore, the artistic experiment does not aim at new knowledge that is accessible to everybody or at dominance over nature (Berg, 2009, p. 54).

For this reason, the linguistic usage draws criticism from its own ranks. In the 1960s, the author, poet and editor Hans Magnus Enzensberger and the novelist and poet Helmut Heißenbüttel resolutely denied the appropriateness of the term in this field. Enzensberger disclaimed any relation between experiment and literature as "nonsense"

and "simple bluff" (Enzensberger, 1962, p. 309f) while Heißenbüttel found that the term "experimental" replaces the term "revolutionary" (Heißenbüttel, 1972, p. 133). However, he argued for using the term "trial", if the author does not know beforehand what he is doing. He refused to call a probing, enquiring linguistic exploration an experiment, since "an experiment proves what one already knows" (Schwerte, 1968, p. 401). Obviously, this criticism was based on a narrow transfer of the deductive hypothesis-testing concept of experiments in science, which was dominant at that time.

Thus, the question arises, whether experimentalism in the arts is nothing more than a late and dubious successor to experimentalism in science. Is the term "experiment" in the context of the arts nothing other than a badly chosen metaphorical expression? (Schwerte, 1968, p. 388) The literary scholar Hans Schwerte negated this question by referring to the age-old linguistic tradition in literature: He brought to mind that Novalis (i.e. Georg Philipp Friedrich Freiherr von Hardenberg) (1772-1801), a poet, author and philosopher of early German Romanticism, was one of the first to transfer the term from natural philosophy into the realm of the arts. At the end of the 18th century, in the context of the evolution and differentiation of the so-called "two cultures" (Snow), the early romantics strove for a reunion. Novalis advocated "to experiment with images and terms in the imagination in a similar manner as physical experimenting" (as cited in Schwerte, 1968, p. 395).

Furthermore, Schwerte referred to the French writer Émile Zola, who wrote his novel *Le roman expérimental* in 1879. Zola proposed for discussion that a novel might be an experimental composition or an instrument, which enables observations to be made and socio-scientific and psychological insights to be gained. The experimental aspect was meant to be bound to the content of the artwork, i.e. the event and characters described in the novel, not to its linguistic form. However, later on, the focus shifted to the form of the work; poetic language became the material of experimentation. This was the sense in which Nobel laureate Thomas Mann used the term, not to mention renowned authors such as Gottfried Benn, Berthold Brecht ("experimental theatre"), Friedrich Dürrenmatt and Max Bense ("experimental writing") (Schwerte, 1968).

Congruent with this line of argument is also the before mentioned fact that the terms "experiment" and "essay" are historically related. The essay and the experimental method emerged simultaneously. Experimental research and reflection in essay form seems to be the result of a philosophy that is based in practice, argued Gunhild Berg (2009, p. 55). Indeed in the 17th century natural philosopher, chemist, physicist and inventor Robert Boyle described his air pump experiments in the form of an essay (Hentschel, 2000, p. 15).

While the discourse on experimentalism in the arts reached a first peak in the 1960s and 70s (Schwerte, 1968; Heißenbüttel, 1972; Gombrich, 1984), scholarly research on this subject has recently entered a new chapter. Michael Gamper conducted a tri-annual research project, which resulted in a profound appraisal of the experiment in literature from 1580 to 2010 (Gamper, Wernli & Zimmer 2009; 2010; 2011) – a body of knowledge that will presumably strengthen the confidence of the discipline to be a true field of experimentalism in its own right.

Also worth mentioning is recent cross-disciplinary research carried out by Stefanie Kreuzer that compares experimental practice in literature, theatre, film, music, and fine arts. She concluded that in the various art fields experimental approaches take place on three levels: First, on the level of form (test, combination or new contextualisation of text, material, media, or sound); second, on the level of processes and methods (as for example the invention and application of random techniques); and third, on the level of addressing the audience (foiling or irritating the attitude and expectations of the audience; enabling new ways of reception) (Kreuzer, 2012, p. 14).

However, this characterisation by Kreuzer might provoke the question whether these features do not characterize the modern arts as such. The traits described above might be characteristic of the creative fields as such – but perhaps to a particular high degree in experimental approaches? Indeed, Schmidt stated that the ability to extend the canon is a measure of the quality of experimental artwork (Schmidt, 1978, p. 12).

Experiments in design practice

Apart from the experiments of renowned Renaissance artists and artists-researchers, experimentalism in design was livened up by the attitudes of the Modernist Movement. Walter Gropius (1955), the founder of Bauhaus, to name but one, used the term "experiment" frequently. He called the school, its programme and projects an "experiment", and the Bauhaus workshops "laboratories". Indeed, modernist architects and designers left traditions behind and put innovative and unusual shapes, new materials, construction methods, and so on to the test. They took risks, without prior knowledge as to whether the results would meet their expectations.

At least from the 1950s onwards the term "experiment" has become widespread in the design community, as a literature review in the German design magazine *form, Zeitschrift für Gestaltung* indicates. A query in the online-archive shows 350 hits for the term "experiment" (2014c) and its inflections during the period 1957-2007. A closer examination of the articles and reports reveals that the focus of the design journalists, designers and companies is placed on innovative outstanding products that attract particular attention from both the media and the marketplace. By "experimental designs" they generally mean products that stand out from accustomed shapes, established product categories, and familiar use, and products that challenge the borders of technical feasibility or cultural acceptability. In this sense, interior designs and furniture designed by Verner Panton and Luigi Colani in the 1970s were prototypical experiments.

Further evidence for this use of the term in the design community can be found in recent literature. Gerrit Terstiege for example introduces in the publication *The Making of Design* (2009) under the heading "experiments", artifacts that are spectacular but far from being ready for production or use; indeed this was not at all the intention of the creators. Amongst others Terstiege presents *Living Systems* objects designed by Jerszy Seymour and his team. (Fig. 3) The furniture are made from bio-plastic created from potato starch, milk, alcohol, and food dye and moulded in open casts made out of sand and clay. With this experiment, he intends to revive methods of pre-industrial craftsmanship and to make a statement on design-it-yourself and design autonomy. Another example is the *Venus Chair*, created by Tokujin Yoshioka, which is made of natural crystals and grows in a tank as crystals form on a sponge-like substrate. (Fig. 4) Yoshioka reveals only that *Venus Chair* is formed by „using the laws of nature and embodies a beauty born of coincidence". The exact chemical formula of the substance he keeps secret. (Terstiege, 2009, p. 167)

However, sometimes the term experiment is also claimed for much less extraordinary, eye-catching products. Gareth Williams curator at the Victoria & Albert Museum presented in *The Furniture Machine* under the title "material experiments" prototypes and products from the museum's collection. Alongside some striking pieces Williams' selection also includes the rather unpretentious *Air Chair*, designed by Jasper Morrison; a chair that is made out of polypropylene with glass fibre added and produced by means of an innovative air moulding technology in a series of hundreds of thousands of units. (Fig. 5) In order to address the reasons for conducting experiments in design practice, Williams points out that "it is important to note that individual designers and large-scale

manufacturers experiment in these ways for very different reasons. For the designers, experiments are part of their personal line of enquiry, but most industrialists will only innovate if they are assured of a more cost- or time-efficient production process as an outcome" (Williams, 2006, p. 90). Although the three examples differ much from each other, they have in common that they don't provide transferable knowledge which is accessible to the design community.

Figure 3: *Living Systems*, designed by Jerszy Seymour. Presented in the exhibition "Home Stories: MyHome – Seven experiments for contemporary living", Vitra Design Museum, Weil am Rhein 2007. (Photo credit Jerszy Seymour Design Workshop)
Figure 4: *Venus Chair*, design by Tokujin Yoshioka. Presented in the exhibition "Second nature" at 21_21 Design sight, Tokyo, 2008. (Photo credit: Masaya Yoshimura)
Figure 5: *Air Chair*, design by Jasper Morrison, manufactured by Magis, Italy, 1999. (Photo credit: Tom Vack)

Repeatedly such experiments in design draw criticism that they are not based on hypotheses let alone reflection or contextualisation within a theoretical framework (Gros, 1987, p. 85; Bürdek, 2010, p. 32). This criticism is valid, but at the same time it greatly resembles the arguments brought forward against experimentalism in literature by Enzensberger and Heißenbüttel. Indeed, experiments in design practice show – at best – few of the essential attributes that define scientific experiments. Rather, as stated before, the term "experiment" indicates objects that show "novel, daring expressions, forms and compositions" (Olbrich, 1989, p. 404), and, in the words of Bürdek (2010, p. 33), "pushing the boundaries of traditional design methods". In this respect, design experiments show commonalities with experiments in literature. However, picking up Hacking's thesis that a major role of physical experiments is "the creation of phenomena", it can be argued that this is also true for experiments in art and design. But whereas scientists create the phenomena in order to analyse them with respect to the laws of nature, artists and designers create phenomena because they are interested in the aesthetic impact, the psychological effects, and the public attention triggered by the artefacts.

Experiments in practice-led design research
Whilst experimentalism in design practice is almost a century old, it has only just begun in terms of academic design research. Many scholars involved in practice-led design research use the term frequently when describing their research projects, and in dissertations the role and contribution of experimental practice is reflected upon (Rust, Whiteley & Wilson, 2000; Niedderer, 2004; Sokoler, 2004). Meanwhile, there are few

generic reflections on experimentalism in design, design research and its relation to other disciplines (Koskinen, Binder & Redström, 2008; Redström, 2011; Hall, 2011; Koskinen, Zimmermann, Binder, Redström & Wensveen 2011).

However, the difference between experimentalism in the context of design practice and design research is distinct. "It is the theoretical scaffolding that makes the difference", argued Ilpo Koskinen, Thomas Binder and Johan Redström (2008, p. 47). They position design experiments right from the outset in an academic research context: "By 'design experiment', we refer to pieces of design carried out as a part of a research effort." (Ibd.) In fact in practice-led design research, experimental designs are undertaken in order to gain new knowledge and insights, to advance understanding, for example to identify causal relations between various factors or to improve insight into cultural, social or psychological issues and – last but not least – to contribute to the knowledge base of the discipline by developing new frameworks, theories, methods and approaches. In order to shed light on the productive interplay between creative 'practice', i.e. the doing and making on the one side, and the discursive reflective part in terms of observation, hypotheses, reflections, inferences, arguments, knowledge creation and theory construction on the other, four experimental design projects are presented and discussed below. Since they stem from the realm of research receiving national funding as well as doctoral studies and ensure publication of the results, there is no doubt that they qualify as research projects. They prove that experimentalism in design research is as manifold as described by Hacking with regard to experiments in the sciences. Design experiments can proceed in various ways: Inductive and deductive approaches, long-term projects (or rather research-programs), which oscillate between induction and deduction, and 'happy meetings' of theory and practice can be identified.

Apart from these different approaches, the case examples also show, that design research experiments take place in distinct settings, as described by Ilpo Koskinen, Thomas Binder, and Johan Redström (2008). They identified three established 'locations': 'the lab', 'the field', and 'the gallery' (or 'the showroom', as it was later labelled by Koskinen et al (2011)). According to them (2008; 2011), the idea of 'the lab' stems from the natural sciences and represents the mainstream of design research in technical design disciplines. The making and doing typically serves the purpose of testing a hypothesis in a controlled setting or to identify causal mechanisms between variables. The idea of 'the field' is based on social sciences experiments; here the experiment is placed in a naturalistic setting and the researcher observes or tests what happens to it in this context: how ordinary people or the audience understand it, think about it, use or react to it. The 'gallery', which is rooted in art, is meant to be a place for the final presentation of the design work and its process for knowledge dissemination as well as enabling experience and reflection.

Case examples
C-furniture: Research conducted at the C-Lab at the Academy of Art and Design Offenbach, Germany, between 1994 and 2003 gives insight into a project that started with a deductive, hypothesis-testing approach and took place in the lab, in it's first phase. The research was initiated from studies by economists and engineers such as *The Second Industrial Divide* by Michael J. Piore and Charles F. Sabel (1984), *The Virtual Corporation* by William H. Davidow and Michael S. Malone (1992) or *Mass Customization* by Joseph B. Pine (1993). These studies announced massive changes in the production and the economic system, caused by the rise of digital technology. In parallel one could witness rapid progress in the field of machine tools such as CNC-milling centres and laser cutters. Since design or rather industrial design will be heavily

affected by the transformation from an industrial to a post-industrial society, Jochen Gros, founder of the C-Lab, took up the issue and projected possible and likely consequences and developments in the field of design which was not the focus of the economists. He put forward several hypotheses: for example the rise of a 'New Arts and Crafts'-movement or a 'scenario of virtual production', where virtual products (i.e. CAD data files for production) can be distributed via the internet, get customized and produced on demand at decentralised workshops close to the customer (Gros, 1997; 2001a, 2001b). However, these ideas were still rather hypothetical in the 1990s, lacking almost any concrete proof. Thus, Gros and his team investigated within the field of furniture design the implications of the hypotheses. What are the key technical, aesthetic and semantic characteristics of products suitable for the scenario? Does the digital technology favour new aesthetics or product semantics as at the beginning of the 20th century industrial mass production favoured the so-called "good form"? Two research projects funded by the Federal Ministry of Education and Research enabled basic and applied research. The main results of the research were first, a scholarly piece which contextualises the current technological upheaval in a design historical and societal perspective; second the development of 50 digital wood joints including CAD/CAM-data distributed via the Internet[4], two furniture collections, experiments in the field of the 'New Arts and Crafts' and 'art customization', conducted in cooperation with an artist (fig. 6-8); and finally a catalogue of general design principles for the creation of digital furniture which derived from inductive reasoning of the created artefacts (Gros, 2001b; Gros & Steffen, 2003; Steffen, 2003, 2006).

Obviously the experimental designs and the physical doing and making were necessary for testing the technical feasibility and thereby to prove the hypotheses in order to verify (or to refute) concepts such as 'virtual production' or 'art customization'. Furthermore the experimental designs serve to exemplarily concretize these concepts as non-discursive, visual artefacts in order to illustrate and communicate the underlying ideas to a broader audience.
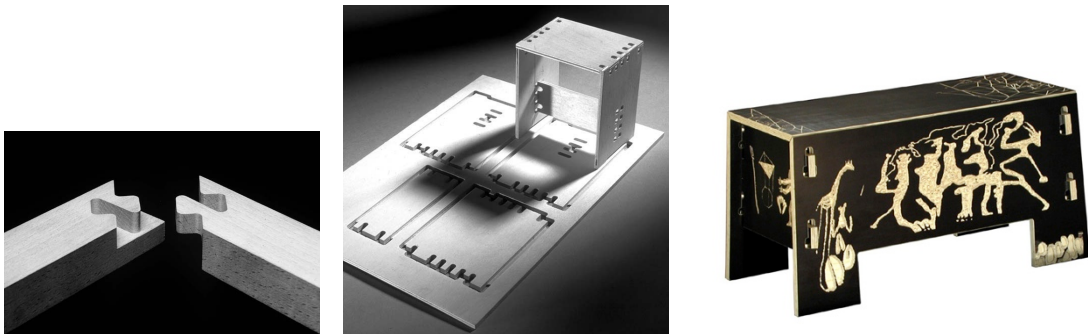

Figure 6: *Digital wood joint*: a corner connection, designed by C-Lab, 1997. (Source: archive author)
Figure 7: *C-Stool*, a CNC-compatible redesign of a three-board stool, designed by Jochen Gros, 1994. (Source: archive author)
Figure 8: New Arts and Crafts: *Trixel-Planet* relief by Frank Reinecke, CNC-engraved on a chest, 2000. (Source: archive author)

Swiss Symbols: An ongoing design research project conducted at the Lucerne School of Art and Design and commissioned by the Swiss National Science Foundation (SNSF), also chose a deductive approach. The project analyses, as the title suggests, *Swiss Symbols* with a focus on souvenir product semantics. Switzerland's image abroad is strongly shaped by the tourist gaze who associate the country with the Alpine mountain

scenery, Edelweiss, cows, cheese, chocolate, watches and the two symbolic figures of Heidi and Wilhelm Tell. This image has hardened into stereotypes – both within and outside of the country. Since the 19th century the touristic outside gaze created in reciprocal exchange processes a visual imagery which the country has made it's own. Hence during the last decade prominent opinion leaders claimed that Switzerland was in need of new visions and a more innovative self-image. It is said that the current crisis is not least a crisis of out-dated images. In this context the research team, led by Franziska Nyffenegger, conducted cultural-historical research on the emergence, development and successive renewal of Swiss national symbols by means of literature studies and analysis of a corpus of more than one thousand souvenirs, regional arts and crafts products as well as everyday products with a touch of 'Swissness'. Based on a semiotic analysis of these artefacts a hypothetical framework was developed in order to guide and reflect the experimental design project conducted in cooperation with six invited artists and designers. The framework comprises various typical or possible references from which Swiss symbols might derive (such as nature, foodstuff, societal values, political culture, humanitarian culture, etc.) and beyond that, artistic innovation strategies (such as formal aesthetic innovation, double coding, ironic treatment, infringement of taboos, deconstruction, etc.). (Fig. 9-11). In the next stage of the project the new designs that challenge the cliché in various ways will be used to prove and refine the framework. Furthermore, the distribution of the works via exhibition, public discussion and publication aims at triggering and contributing to a renewal of the common clichés. As well as the research at the Offenbach based C-Lab, this project is labelled as use-inspired basic research, a concept promulgated by Donald E. Stokes (1997) and adopted by the SNSF. The goal of either knowledge building or application and broader societal impact are no longer considered to be mutually exclusive.
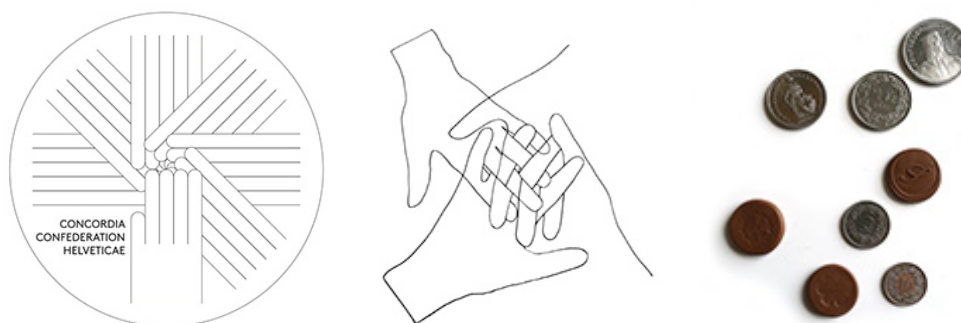

Fig. 9-11: Logo *Concordia Confederation Helveticae;* Logo *Swiss political consensus;* Coins *Getting values of Swiss cultural policies across the people;* designed by Sibylle Stoeckli, 2014. (Source: Sibylle Stoeckli)

Paperness: An example of a truly inductive approach to experimentalism in art and design is the work of textile artist-researcher Nithikul Nimkulrat. Her dissertation conducted at the University of Art and Design Helsinki (now Aalto University) aimed to investigate the relationship between a physical material, in her case paper string, artist's thoughts in the creation process, and artistic expression of the artefacts as received by an audience. Therefore she utilized her own craft practice as a vehicle of theoretical inquiry (Nimkulrat 2009). Throughout the five phases of research, the entire working process – her hands-on practice and experiences with the 'materialness' of paper string, her 'reflection-in-action' and the artefacts in various stages of progress as well as the two exhibitions *Seeing Paper* in 2005 and *Paper World* in 2007 (fig. 12-13) and the comments and opinions of the visitors – was documented in diaries, photography, sketches, diagrams and questionnaires. Subsequently she revisited the

documents and based on Merleau-Ponty's and Heidegger's phenomenology she interpreted the tacit knowledge embedded in the working process and it's results. Phenomenology appeared to be relevant, since it examines the ways in which an environment shapes human experience and understanding. Consequently, she noted every detail such as the different types of paper string, knotting techniques and how she experimented with the material by pulling and knotting the strings more or less strong; in turn the material articulated through it's physicality and shaped her manipulation in the creative process. Amongst other things she noted that "diary writing facilitated her self-awareness of cumulative thoughts, intentions and decisions" during work; and some "thoughts or actions, which seemed trivial in the creative process, shed light on the overall process after it was completed" (Mäkelä & Nimkulrat, 2011, p. 126). Step by step Nimkulrat uncovered and put into writing the tacit dialog between the material, the artist and the message of the finished artefact; furthermore she exhibited her works in galleries and learned from the perception and interpretation of the audience, which she took into account in her second work cycle. Finally, she came to the conclusion that "positioning craft practice in a research context can facilitate the reflection and articulation of knowledge generated from within the researcher-practitioner's artistic experience, so that the knowledge becomes explicit as a written text or as a means of visual representation. Research can not only transform ways of designing or making artifacts, but also theoretically inform practice", she argued (Nimkulrat 2012, p. 1).

Figure 12-13: Two creative productions and exhibitions by Nithikul Nimkulrat: left *Seeing Paper*, 2005; right *Paper World* series displayed in a gallery converted from a wooden house in Finland, 2007. (Source: Nithikul Nimkulrat)

Hertzian Tales: The work of Anthony Dunne and Fiona Raby, discussed already by Koskinen, Binder and Redström (2008) as an example of design experiments located in the gallery or showroom, is also instructive in terms of the approach the two designers choose. A more detailed analysis of their way of working shows, that it echoes the idea of 'happy meetings' of theory and experiment (Hacking), where neither theory nor observation and experiment proceed each other. In his dissertation *Hertzian Tales* Dunne ([1999] 2005) deals with electronic objects. He criticised the way in which they only serve utilitarian functions, while the ritual and symbolic functions of objects remain unconsidered. Thus he made an argument for a branch of design research beyond commercial interests, where design – similar to art – can inspire imagination and experience and has the potential to offer 'complicated pleasures'. In order to substantiate his subversive approach, he created various electronic objects. One of them, the Faraday Chair, is based on the principle of a Faraday cage which insulates its user from electromagnetic fields (fig. 14). Parallel to the experimental design Dunne developed a 'critical design' toolbox, containing strategies and concepts that teach how to create these kinds of 'post-optimal objects'. He describes for example strategies for

'estrangement' and 'alienation', for 'user-unfriendliness' and 'para-functionality'. Dunne comments on the meeting of experimental practice and theoretical concepts as follows: The objects "are not necessarily illustrations of the ideas discussed in earlier chapters, nor are the earlier chapters an explanation of these proposals. They evolved simultaneously and are part of the same design process" (2005, p. XVIII). Clearly, there was no hypothesis about 'critical design' at the beginning from which the experimental design was deduced. Nor were there objects from which the theory derived. Instead the design works and the theory developed side by side, driven by the basic idea.

Figure 14: *Faraday Chair*, designed by Anthony Dunne, 1999. (Photo credit Lubna Hammoud)

Discussion and conclusion

Currently the scientific community at large, including the design research community in particular, seems to associate experimentalism primarily with the sciences, in which certain characteristics are prevalent: Their main objective is knowledge creation; they demand an objective, unbiased approach; they refer to a hypothesis or theory etc.. When we interpret the term "experiment" in this narrow sense than we accept the primacy of science as regards to experiment and we have to infer that the arts – including creative design practice – use the term in a biased manner: A friendly interpretation is the "metaphorical use" of the term; a more harsh interpretation is that it is misused or abused by the arts, motivated by the aim to participate in the prestige of the sciences.

Clearly such a narrow usage of the term "experiment" has advantages: It facilitates communication, judgement, and either inclusion in or exclusion of the community of researchers, who experiment in a scholarly manner. It helps to draw clear boundaries between practice-led design research which is meant to conduct proper experiments in order to contribute to the body of knowledge on the one hand, and professional design practice which conducts a rudimentary form of experimental action and should be labelled "trial and error", on the other (Steffen 2012a)[5]. However, when we take into account the common origin of scientific and artistic experiments in the Renaissance, the current reconstruction of the history and tradition of experimentalism in the arts, and interferences between experiments in science and in the arts, this judgement would seem to be ignorant or premature. Frequently, it serves the protection of vested interests. Instead of drawing clear boundaries and making distinct judgements on what "is" or "is not" an experiment we might take a position that accepts that experimentalism has many faces. In the sciences, experiments have to follow certain rules and lead to definite results, as stated above. In the arts (including design), experimenters enjoy the freedom to establish their own rules, to create innovative artefacts, new processes and methods, to address the audience in an unexpected manner and to extend the canon. Thus, a designer who claims to experiment in the studio should deliver artefacts that are truly novel in some aspect, but he/ she is not obliged to deliver a concise hypothesis or

theory. This will subsequently be the challenging interpretative work of design theoreticians or historians. However, practice-led design research overlaps both fields (fig. 15). Clearly, in the research context, knowledge creation is more important than the experimental artefact, which initially takes an instrumental role. Thus, from a practice-led designer-researcher, who is obliged to contribute to the body of knowledge, we can and must expect that he/ she is able to place his/ her experimental approach within a theoretical framework and to deliver a thesis. The contribution of the artefacts in practice-led design research to the extension of the canon *might* be weak. Accordingly, Kristina Niedderer stated after completion of her practice-led dissertation entitled *Designing the performative object:* "What the project did not provide, and was not meant to provide, was a body of creative work that would stand for itself. […] Furthermore, not having to produce a body of 'artistic work' that would stand for itself was a liberation, which allowed for a much freer experimentation." (Niedderer, 2008, p. 208) Nonetheless a contribution to both fields, the body of knowledge and the artistic canon, is within the realm of possibility. For instance, some of the experimental artefacts developed in the 1990s at the Offenbach based C-Lab are included in the collections of the Museum of Applied Arts in Frankfurt, as well as in Hanover and Vienna. The characteristics of a design experiment – whether it pushes the aesthetic boundaries and extends the canon or whether it contributes to knowledge creation – depend basically on the earlier defined objectives.
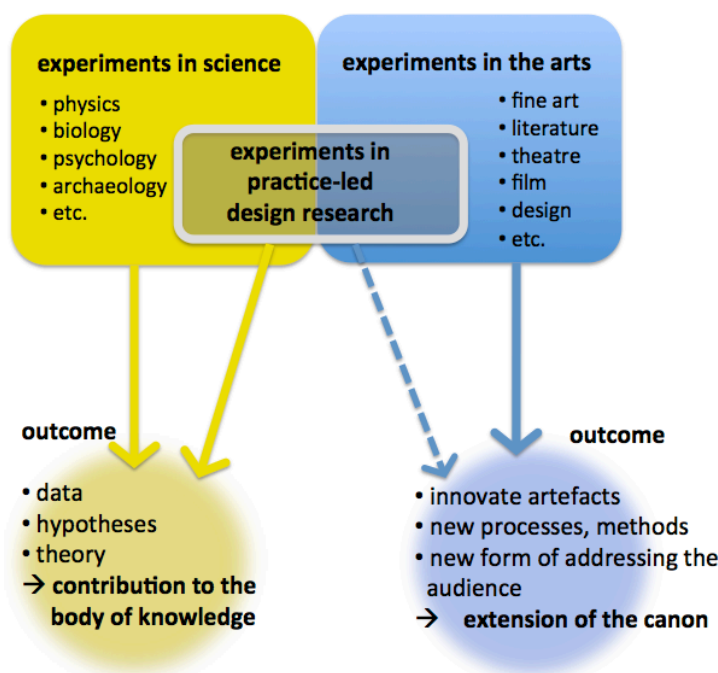

Figure 15: Mapping of experiments in science, in the arts and in practice-led design research. (Author's illustration)

In summary, the discussion of the case examples should demonstrate, that even within practice-led design research experimentalism is manifold. Hacking's warning that "any one-sided view of experiment is certainly wrong" (1983, p. 166), brought forward in order to avoid a narrow inductive or deductive view of experimentalism in science, also appears to be true with respect to design research. The various co-existing approaches he identified in science are also to be found in this field. Moreover, the reference to the

philosophy of new experimentalism broadens the knowledge of what constitutes an experiment. It emphasises the relevance of the material dimension, but at the same time it does not renege on the commitment to contribute to the production of new knowledge and theory. Finally, it should become apparent that an exclusive appropriation of experimentalism on the part of the scholarly research culture in opposition to creative practices in the arts seems to be untenable. It rather stands to reason that practice-led design research has the potential to following up the experimental practices in Renaissance and to reconcile the "two cultures" – not necessarily science and the arts, but the culture of scholarly discursive knowledge and the presentational symbolism of the arts.

Acknowledgements

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Notes

[1] The term "practice-led design research" is used for practical reasons since it was introduced and has now more or less become established in the discussion for more than a decade; it is used as an umbrella term for the discourse on "practice-based", "practice-driven", "project-based" or "artistic" design research. However, I agree with Ilpo Koskinen who stated that from his point of view the term is "misleading and rhetorically dangerous" (Koskinen, 2009, p.16). Indeed the term fails to give due weight to the theoretical part of academic research. Elsewhere, I have introduced the term

"practice-integrating design research" in order to express that creative practice is (in a manner to be specified) embedded in a scholarly research process (Steffen 2012b).

[2] Re-translated from the German by author.

[3] The Hall effect, discovered by the American physicist Edwin Hall in 1879, specifies the production of a voltage difference across an electrical conductor, transverse to an electric current in the conductor and a magnetic field perpendicular to the current. See http://en.wikipedia.org/wiki/Hall_effect

[4] See www.flexiblestream.org/project/50-digital-wood-joints .

[5] According to Jürgen Mittelstraß (1980), the trial-and-error method is solution-oriented, problem-specific, and it does not aim at generating knowledge or theory – three features, it shares with Donald Schön's concept of the "practitioner's reflection-in-action". In his treatise *The Reflective Practitioner. How Professionals Think in Action* Schön pointed out the similarities between experiments in professional practice and in science. He stated: "In the on-the-spot experimenting characteristic of reflection-in-action, the logic of hypothesis testing is essentially the same as it is in the research context. If a carpenter asks himself 'What makes this structure stable?' and begins to experiment to find out – trying now one device, now another – he is basically in the same business as the research scientist." (Schön 1983, p. 147). On the other hand Schön clearly accentuated important differences. Unlike the laboratory experiment, which aims to understand things and demands that we test hypotheses in an objective, unbiased manner, experiments under conditions of everyday professional practice aim to improve things or transform a situation. Here understanding is not the ultimate goal, but rather a means for successful intervention. In Schön's words: "The practitioner has an interest in transforming the situation from what is to something he likes better. He also has an interest in understanding the situation, but it is in the service of his interest in change" (ibid., p. 147). Thus, the practitioner stops his inquiry when he achieves change for the better, "even when he has not exhausted his store of plausible alternative hypotheses" (ibid., p. 151).