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Experimental Systems Future Knowledge in Artistic Research

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Michael Schwab (ed.)

Experimental Systems

Future Knowledge in Artistic Research

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Introduction

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According to Stephen Shapin's explanation of Robert Boyle's experiments with an air pump, a "matter of fact" is a manufactured piece of knowledge that exists on its own account and is, as such, a concept upon which a new empirical science could be built (Shapin 1984; Shapin and Schaffer 1985). When, for example, Boyle demonstrated in experiment twenty-seven that the ticking of a watch could no longer be heard after the air had been removed from the pump, this new and surprising matter of fact existed from that moment onwards, calling for scientific investigation and theoretical explanation.

To some extent, works of art may also exhibit such matter-of-factness. While works of art are produced through culturally and sometimes technically complex processes, they often appear self-determined and *just there*, as if they were natural objects. In aesthetic philosophy, this aspect has historically been discussed as the autonomy of aesthetic judgement (Kant 1987) or the work of art (Adorno 1984), while in more recent accounts, such as in Jacques Ranciére's (2004, 23) definition of the "aesthetic regime of art," an artwork is "a product identical with something not produced." Traditionally, artists have achieved matter-of-factness through "*complete* familiarity" with the style, as Igor Stravinsky ([1942] 1970, 128, my emphasis) demands of the performer, or, more recently, through what has been called "deskilling" (Buchloh 2004), a process of unlearning artistic habits, which may, indeed, imply a "reskilling" (David Joselit in Baker et al. 2000, 208) precisely in support of artworks as matters of fact. For example, Helmut Lachenmann (2004, 64) demands that performers of his "musique concrète instrumentale" re-learn their playing techniques in order to evoke "a mode of listening previously excluded from the musical medium ... which treats sound as a phenomenon of nature."

It is striking that in a matter of fact the difference between a culturally produced and a natural phenomenon disappears, which leads Bruno Latour (1993) to doubt whether "culture" and "nature" actually pre-exist such hybrid objects. Rather than drawing ontological conclusions, if we focus on the particular type of experience that matters-of-fact entail, links with artistic practice may be made that allow one to suggest how something like "artistic research" can be possible. These do not arise from setting art in contrast to science; rather, they constitute an attempt to understand what the "practice turn in contemporary theory" (Schatzki, Knorr Cetina, and Savigny 2001) might be when it includes artistic modes of investigation.

The chapters collected in this book trace some links between experimentation and artistic practice—by comparing the laboratory and the studio, by focusing on material practice, by describing systems of creation, or by highlighting temporal or experiential dimensions. Across these—sometimes contradictory—approaches, shared ground may sometimes be difficult to see, perhaps appearing only on the horizon, as idealised pure research practice that is outside the historical constraints within which any one approach operates, be it artistic practice, history of science, art criticism, or science and technology studies. However, what may look like contradictions caused by the various approaches to the topic may also be due to differences in the research practices themselves, which are presented in the chapters and which remain materially situated and historically distinct.

Nevertheless, to create a conceptual neighbourhood of research practice, Hans-Jörg Rheinberger's research into what he calls "experimental systems" has been chosen here to provide some common concepts and to focus critical reflection. Rheinberger is particularly relevant because he has suggested some form of proximity-in-difference between artistic and scientific research (2012b, 13), an approach that is supported by a limited set of secondary literature in which reference to his work is made (such as Bexte 2012; Blättler 2010; Boulboullé 2007; Hensel 2009; Rickli 2011, 2012; Schenker and Rickli 2012; Schmieder 2010; Schwab 2012a).

Thus the question to be asked is not whether the artist is also a scientist or vice versa, but what material and practical ground can be suggested for experimental research of any kind and how this research is conditioned by and develops into the various epistemic contexts within which it is situated. Methodologically, the book assumes that for the empirical sciences, and molecular biology in particular, Rheinberger's work may already provide such a grounding; each chapter seeks to extend this to include limited selections of artistic projects, practices, or lines of thought that originate from contemporary art, art history, or criticism. This necessarily requires fresh interpretations of Rheinberger's work, which, as it is applied to art, may either be adapted and reconfigured or criticised. It would be fascinating to return to the history of science with these interpretations in mind in order to investigate whether an understanding of experimentation in artistic research may add dimensions to this concept that are relevant also to experimental science.

Rheinberger's thinking allows one to unpack some of the material implications of matters of fact that more anthropological or sociological approaches may miss. Rheinberger suggests that matters of fact are complex spatiotemporal entities that emerge not in individual experiments but rather in complex experimental settings—"experimental systems." A move from a single experiment to an experimental system is necessary since it is the system that provides the context *against which* an experiment carries meaning. When looking at the artistic examples that are provided in this book, it is not always easy to tell what kind of systems are set in motion, if the word "system" is indeed appropriate to describe a sense of experimental coherence within an artist's practice, a body of work, or even a school. The very specific understanding of experimentation through

experimental systems that Rheinberger suggests may thus limit the usefulness of his work in the context of artistic research and the criticism that may potentially be raised. At the same time, drawing the circle slightly wider—by including examples of artistic experimentation that do not dovetail into what is in the end a model derived from a subset of science—allows for modes of artistic thinking to come to the fore that may otherwise be missed. Thus, while the phrase "experimental system" in both the title of this book and in its chapters does refer directly to Rheinberger's work, it is generally applied in a slightly more elastic way.

A more open approach to experimental systems seems permissible because they intrinsically require wider experimental cultures as well as an "experimental spirit" [*experimentellen Geist*] (Rheinberger 2012b, 13). During my conversation with Rheinberger (chapter 15 of this book), it became clear that a particular type of work ethic, experience, and sensibility is required in experimental systems that can also be found in artistic practice: dedication to a limited sets of materials, attention to detail, continuous iterations, and the inclusion of contingent events and traces in the artistic process, allowing the material substrata to come to the fore as a site where traces are assembled.

To unpack experimental systems, Rheinberger (1997, 102–13; 1998) distinguishes between two distinct but interdependent types of spaces: the graphematic and the representational space. The graphematic space may be defined as a space constituted by material practice that transforms what is initially at hand ("stuff") into an object of investigation (an "epistemic thing"). At the same time, this object of investigation is also an element in spaces of representation within which it carries signification. In other words, an epistemic thing *is* a particular point of contact between those two types of space, where the one pierces or folds into the other. As Rheinberger (1997, 28) writes, experimental systems "inextricably cogenerate the phenomena or material entities and the concepts they come to embody." In what follows, I offer a more detailed discussion of the relationship between the graphematic and the representational space to suggest an approach that makes room for options that artistic research brings to the table, such as those discussed in this book.

Initially, the epistemic thing may be conceived as nothing but an empty point of contact between the graphematic and the representational space. It is first of all an unknown that enters representation as a question: *what is this that I suddenly have in front of me?* In its most basic form, one may conceive of research as the ability to register a question with an unknown answer in a space of representation. The initial question, however, cannot strictly speaking represent anything; it only provides a site where the two spaces touch and where future knowledge can be inscribed and has, in fact, already been inscribed from the moment of contact. This is to say that even when we have gained representational content by having learned more about the epistemic thing, we continue this initial inscription, shaping and re-shaping the epistemic thing "as a traceable conformation" (Rheinberger 1997, 111, punctuation adjusted).

While this shorthand description may plausibly summarise how experimental research contributes to scientific knowledge, it is by no means clear if such a theory can be transposed to the arts. Three major problems deserve particu-

lar attention. First, there is an inner relationship between artistic practice and experimentation that makes it difficult to identify what kinds of (credible) contemporary art may *not* rely heavily on experimentation either in the production or reception stage. As a consequence, differentiating between artistic practice in general and artistic research practice in particular is problematic; both seem to be doing similar things, such as applying paint to a canvas or operating keys on a piano driven by the idea of creating or re-creating something "original."

Second, the way in which something can be "original" has become complicated in the course of the twentieth century, making ideas of "progress" or "future" in art a thing of the past. As I have discussed elsewhere (Schwab 2009), there is a difference between a practical and a theoretical approach to artistic research, which could be mapped onto Rheinberger's distinction between graphematic and representational space. While the relevance of artistic research that can be associated with the graphematic space—that is, with materially and socially bound practice—has increased over the last decades, and while processes of inscription dominate artistic practice, there is a widespread reluctance, if not refusal, to partake openly in the knowledge society. There are very good artistic reasons to hesitate, given that an engagement with such epistemic spaces completely transforms the work; but there are also less good reasons—for example, when the exquisite status of the art object that developed in the later part of the nineteenth century is, consciously or not, maintained to maximise profits (Graw 2009).

Third, we still live in a "so-called crisis of representation, in which an essentially realistic epistemology, which conceives of representation as the reproduction, for subjectivity, of an objectivity that lies outside it[,] projects a mirror theory of knowledge and art" (Jameson 1984, viii). While this may be less so today, in terms of artistic research, it remains unclear what kinds of representational spaces could allow for more moderate and perhaps local versions of "objectivity," in particular in the context of academia. For instance, outputs from artistic research remain torn between practice and theory components; alternative models for the academic publication of artistic research, such as the notion of "exposition" (Schwab 2011; 2012b; 2012c), with which the *Journal for Artistic Research* (*JAR*) operates, have not yet been sufficiently developed.

Although it could be concluded that for these and other reasons more preparatory work on the part of artistic research methodology and epistemology is required before historically tested concepts such as "experimental systems" can properly be debated, it can also be argued that provisional discussions such as those collected in this book may have an important part to play while the field is still in development. Indeed, despite such difficulties, such discussions can serve to acknowledge that limited sets of materials and unique practices, brought together as part of longstanding engagements with meaning that has not yet been achieved, bring about occasional surprises and a sense of movement that is beyond one's control.

Quoting François Jacob's assertion that experimental systems are "machines for making the future," Rheinberger (1997, 28) is quite clear that such movement—uncontrolled and unpredictable—has consequences for the future. For

a historian, a link between past experimental events and the knowledge that they produced—also in the past, but after the event—seems natural and also applicable to the arts. For example, Marcel Duchamp's readymades, created at the beginning of the twentieth century, seem to have led to the conceptual art of the 1960s. However, an artist immersed in experimentation and lacking (yet) the advantage of historical hindsight may well ask, "which future?" Such an artist, after all, does not know how the future will unfold, which parts of the work may develop or, for that matter, if there is a real future to be had. In other words, "future knowledge" cannot be known as future knowledge when it is made; only a sense of potentiality can guide the researcher.

This brings one back to the connection between graphematic and representational space. It seems more than likely that "history" is one of those representational spaces and that "future" is the historical representation of material potentiality that one has, makes, or experiences in the graphematic space. While there is nothing wrong with "future" *per se*, aspects of representation in Rheinberger's concept of "future" render that concept problematic in contemporary art for the reason discussed above. It thus seems necessary to suggest that for artistic research the link between potentiality and future needs to be relaxed, and to ask how else research can register in a representational space.

Referring to Herman Melville's *Bartleby, the Scrivener*, both Gilles Deleuze and Giorgio Agamben suggest that potentiality can be indicated by a refusal to represent that in itself escapes representation. Such potentiality, in Deleuze's words, must "remain enigmatic yet nonarbitrary; in short, a new logic, definitely a logic, but one that grasps the innermost depths of life and death without leading us back to reason" (Deleuze 1997, 82). For Agamben, "the experiment that Melville entrusts to Bartleby" results in an "experience that has thus retreated from all relations to truth, to the subsistence and nonsubsistence of things" (Agamben 1999, 260–61). Although it may not be necessary to link this "new logic" to "the innermost depths of life and death," a more complex connection between the graphematic and the representational space can be conceived that, in artistic research, may escape futures in which the potentiality of epistemic things is reduced to facts of (propositional) knowledge. In other words, artistic research may produce futures that do not function primarily as (future) handles on a past.

A reconsideration of "future" leads back to Derrida, according to whom *différance*, which motivates the graphematic space, is also deferral. *Another, future* representation is required, which puts into (epistemic) perspective what the graphematic space delivers to representation; this, in turn, fixes an epistemic thing as a past that projects a future. However, could epistemic things also be fixed in alternative representational spaces that are not those of history? Could other representations in other representational spaces be found that operate ahistorically, that is, simultaneously or in different temporal spaces, to the same epistemic end as history does? In research, could one be deferred to another space rather than into historical time?

There is insufficient space in this introduction to attempt to answer such questions; I offer them only to suggest that epistemic things may not always only unfold historically and that the "future knowledge in artistic research" that

the subtitle of this book announces may signal modes of representation, some of which still need to be invented, as alternative spaces within which artistic research can be registered. While many texts in this book accept Rheinberger's notions of "experimental system" and "epistemic thing," the production of a "future" is not always deemed as fundamental to the arts as Rheinberger suggests that it is to the sciences.

This issue becomes most apparent with regard to technology, in particular to "technical objects," which, according to Rheinberger (1997, 245), "embody the knowledge of a given research field at a given time." Technical objects—in the form of apparatus, infrastructures, processes, etc.—can at the same time be characterised as consequences *of* experimental systems and investments *into* experimental systems. In the latter capacity, they make new epistemic things possible, which in time and in other functional contexts may be re-invested. Technology is presented as resource *and* destination for experimental systems, acting as past *and* future and thus as a historical horizon. Relationships between epistemic things and technical objects inside experimental systems are thus necessarily functional. Roles can shift in ways that depend on the practical development of the experimental system (Rheinberger 1997, 30).

There are problems with technology as a resource—for example, regarding access or economic constraints that may influence the course that an experimental system takes over time. But even more problematic for artistic research is the characterisation of experimental systems as producers of technology. Even if we interpret "technology" very broadly—for instance, including formal solutions to artistic problems of the kind that art historian George Kubler ([1962] 2008) organises in formal sequences, such as Greek vase painting—the implication remains that contemporary artistic output can be "black-boxed" to operate functionally in a new experimental setting (Rheinberger 1997, 30). In other words, only within a modernist (that is, a formalist) artistic context can artistic experimental systems feasibly produce results (that is, formal solutions) that have a utility in future research comparable to the enzymatic sequencing of DNA that Rheinberger (1997, 29) mentions as an example of an epistemic thing that developed over time into a technical object. From the vantage point of contemporary art, the dialectic between epistemic thing and technical object may simply not be transferable to experimentation within artistic research; to transfer it raises expectations of utility that are regressive and potentially detrimental to artistic practice.

To be sure, whenever the question of experimental systems in the arts is raised, Rheinberger (2009, 2012a, 2012b, chapter 15 of this book) is quick to add that art and science are not identical, nor need the types of activities that they represent be similar in any way. However, he also suggests that "the decisive task lies in finding a shared ground ... that makes it possible to characterise the relationship between science and art in a way that emphasises the recognition of the *unpredictable*, *without* ... refusing the right for a difference that potentially is irreducible" (Rheinberger 2012b, 13, my translation). In the same spirit, this book, despite the diversity of opinions and approaches that it presents, brings various understandings of "experimental system" into play in the context of artistic practice: some of them support and some of them question the

concept in the context of artistic research. All authors affirm, however, that the notion of an "experimental system," together with its conceptual framework, can effectively be employed to probe more deeply the experimental practices and epistemic dimensions that may be associated with artistic research.

This book follows what can be seen as a narrative trajectory across its fifteen chapters, closing with a conversation with Rheinberger entitled "Forming and Being Informed," in which I ask him about such ideas as "experimental spirit," "experimental space," and the heterogeneity and epistemic "thickness" that is associated with the latter. The way in which space is constituted raises questions concerning technology, and it becomes clear that, in Rheinberger's view, the graphematic research activity remains self-determining. Then follow some passages in which Rheinberger talks about his own experimental methodology and the possible relationships between science and art. The conversation does not refer in any direct way to the chapters; what Rheinberger says should not be read as commentary.

The narrative trajectory starts with "A Theory of Experimentation in Art? Reading Kubler's History of Art after Rheinberger's Experimental Systems," by Stefanie Stallschus, in which Kubler's theory of art—an important inspiration for Rheinberger—is read as a theory of experimentation while keeping in mind the concept of "experimental system." We then fast-forward to the work of a contemporary artist; in "Electrical Images: Snapshots of an Exploration," Hannes Rickli describes his recent research project, his collaboration with natural scientists, and the types of labour and choices that may be involved when an artist rethinks and artistically reworks experimental setups. In "Material Experiments: 'Phenomeno-Technology' in the Art of the New Materialists," Susanne Witzgall focuses on material and experience rather than form and technology in the work of artists such as Karla Black and Nina Canell, suggesting ways in which contemporary artistic practice, even if not explicitly experimental, may share some of the concerns that Rheinberger reflects in his notion of experimental system. Virginia Anderson demonstrates in "Whatever Remains, However Improbable: British Experimental Music and Experimental Systems" that music is particularly suited to expanding notions of material and to scrutinising the liberties that artists can take. Focusing on British experimental music and especially the approach to research within the Scratch Orchestra, Anderson convincingly argues that for artistic research, a distinction between real and fictional material may not matter even when a strict experimental methodology remains in place. In "Of Arnold Schoenberg's *Klavierstück* op. 33a, 'a Game of Chess,' and the Emergence of New Epistemic Things," Darla M. Crispin turns to the role of the performer, arguing that experimental approaches that focus on the realities of performance may result not only in better understandings of the works performed but, ultimately, in better performances.

The knowledge with which artists operate and the artistic research they conduct can be seen as intricately interwoven with different sets of knowledge and different research methodologies. Discussing a specific experimental system in "Research Organs as Experimental Systems: Constructivist Notions of Experimentation in Artistic Research," Peter Peters frames artistic con-

cerns in the context of an interdisciplinary research project by approaching artistic research through "STS"—the field of Science and Technology Studies. A comparable framework can be applied to artists' studios, as Gabriele Gramelsberger suggests in "A Laboratory View of Art"; this could allow a new field of "studio studies" to analyse concrete experimental processes that guide artists in their practice, replacing top-down definitions of artistic research. In "Artistic Practices and Epistemic Things," Henk Borgdorff suggests that one should identify artworks as epistemic things to highlight their essential incompleteness, the role they play in artistic research, and their capacity to enable knowledge to be differently "published" and experienced. In her chapter "Artistic Experiments as Research," Elke Bippus considers the relationship between contemporary art and experimental science, noting that both require intricate knowledge of the systems within which they operate and openness to departures from those systems in order to accommodate novel insights and experiences. Focusing on the importance of "surprise" that accompanies epistemic things as they emerge, Stephen A. R. Scrivener, in "Toward a Practice of Novel Epistemic Artefacts," argues that in design research in particular, approaches that focus on problem solving and reflective practice may limit a researcher's creative options, while a theory of experimental systems can be used to support outcomes that remain surprising. Paulo de Assis, in his chapter "Epistemic Complexity and Experimental Systems in Music Performance" proposes to open up the concept of "work" to show the complex relations that determine a work's meaning, thus allowing artists to manipulate these relations experimentally as a way to enhance our understanding in practical terms. By returning to Hume's conception of the critic, Paolo Giudici argues in "Criticism and Experimental Systems" that the epistemic role that experimental systems can play in art need not and perhaps cannot be restricted to artists and that they must involve modes of reception and judgement, which raises ethical questions regarding the autonomy of experimental systems. In the penultimate chapter, "Epistemic Events," Neal White makes the point that an extended understanding of experimental systems allows for a redefinition of the role of the artist within wider culture. Relating epistemic things to event-structures, a notion developed by the artist John Latham, White argues that artistic research can engage with the temporal forms that synchronise social and cultural life.

Beyond this, the order of the chapters is fairly loose, inviting connections to be made across and within the trajectory—for instance, regarding notions of material, artistic research, or options for contemporary practice. A consistent conviction of all chapters, however, is the *effectiveness* of Rheinberger's work when applied to current concerns in art.

The word "effectiveness" was used by Paulo de Assis, with whom initial ideas for a book on experimental systems were developed, during a conversation at the Orpheus Institute in Ghent. I am a researcher in his ERC-funded project "Experimentation Versus Interpretation: Exploring New Paths in Music Performance in the Twenty-First Century," in which I am contributing to the development of epistemological, methodological, and aesthetic frameworks for artistic research. This book is my initial output in this endeavour.

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REFERENCES

Adorno, Theodor W. 1984. *Aesthetic Theory*. Edited by Gretel Adorno and Rolf Tiedemann. Translated by C. Lenhardt. London: Routledge & Kegan Paul. First published 1970 as *Ästhetische Theorie* (Frankfurt am Main: Suhrkamp).

Agamben, Giorgio. 1999. "Bartleby, or On Contingency." In *Potentialities: Collected Essays in Philosophy*, edited and translated by Daniel Heller-Roazen, 243–71. Stanford, CA: Stanford University Press.

Baker, George, Rosalind Krauss, Benjamin Buchloh, Andrea Fraser, David Joselit, James Meyer, Robert Storr, Hal Foster, John Miller, and Helen Molesworth. 2002. "Round Table: The Present Conditions of Art Criticism." *October* 100 (Spring): 200–28.

Bexte, Peter. 2012. "Beckett im Labor: Zur Grammatik des exakten Nicht-Wissens." *Zeitschrift für Ästhetik und Allgemeine Kunstwissenschaft* 57 (2): 227–38.

Blättler, Christine. 2010. "Demonstration und Exploration." In *Experiment und Literatur: Themen, Methoden, Theorien*, edited by Michael Gamper, 236–51. Göttingen: Wallstein.

Boulboullé, Guido. 2007. "Experimental Systems in Art and Science." In *Say It Isn't So: Art Trains Its Sights on the Natural Sciences*, edited by Peter Friese, Guido Boulboullé, and Susanne Witzgall, 66–79. Heidelberg: Kehrer Verlag. Published in conjunction with the exhibition of the same name, shown at the Weserburg, Museum für moderne Kunst, Bremen.

Buchloh, Benjamin H. D. 2004. "Deskilling." In *Art Since 1900: Modernism, Antimodernism, Postmodernism*, edited by Hal Foster, Rosalind Krauss, Yves-Alain Bois, and Benjamin H. D. Buchloh, 531. London: Thames & Hudson.

Deleuze, Gilles. 1997. "Bartleby; or, The Formula." In *Essays Critical and Clinical*, translated by Daniel W. Smith and Michael A. Greco, 68–90. Minneapolis: University of Minnesota Press. First published 1993 as *Critique et clinique* (Paris: Éditions de Minuit).

Graw, Isabelle. 2009. *High Price: Art between the Market and Celebrity Culture*. Translated by Nicholas Grindell. Berlin: Sternberg. First published 2008 as *Der große Preis: Kunst zwischen Markt und Celebrity Culture* (Cologne: DuMont).

Hensel, Thomas. 2009. "Kunstwissenschaft als Experimentalsystem." *Kunstgeschichte: Texte Zur Diskussion* 19 (March). Accessed 2 June 2013. http://www.kunstgeschichte-ejournal.net/discussion/2009/hensel.

Jameson, Fredric. 1984. Foreword to *The Postmodern Condition: A Report on Knowledge*, by Jean-François Lyotard, translated by Geoff Bennington and Brian Massumi, vi–xxi. Manchester: Manchester University Press.

Kant, Immanuel. 1987. *Critique of Judgment*. Translated by Werner S. Pluhar. Indianapolis, IN: Hackett. First published 1790 as *Kritik der Urteilskraft*.

Kubler, George. (1962) 2008. *The Shape of Time: Remarks on the History of Things*. Rev. ed. New Haven, CT: Yale University Press. First published 1962.

Lachenmann, Helmut. 2004. "Philosophy of Composition: Is There Such a Thing?" In *Identity and Difference: Essays on Music*,

Language and Time, edited by Jonathan Cross, Jonathan Harvey, Helmut Lachenmann, Albrecht Wellmer, and Richard Klein, 55–70. Collected Writings of the Orpheus Institute. Leuven: Leuven University Press.

Latour, Bruno. 1993. *We Have Never Been Modern*. Translated by Catherine Porter. Cambridge, MA: Harvard University Press. First published 1991 as *Nous n'avons jamais été modernes: Essai d'anthropologie symétrique* (Paris: La Découverte).

Rancière, Jacques. 2004. *The Politics of Aesthetics: The Distribution of the Sensible*. Translated by Gabriel Rockhill. London: Continuum. First published 2000 as *Le partage du sensible: esthétique et politique* (Paris: La Fabrique).

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

———. 1998. "Experimental Systems, Graphematic Spaces." In *Inscribing Science: Scientific Texts and the Materiality of Communication*, edited by Timothy Lenoir, 285–303. Stanford, CA: Stanford University Press.

———. 2009. "History of Science with George Kubler." *Texte zur Kunst* 19 (76): 109–12.

———. 2012a. "'Das Wesen der Forschung besteht im Übersteigen von Grenzen': Ein Gespräch mit Wolfert von Rahden über historische und aktuelle Grenzverläufe der Wissenschaften." *Gegenworte: Hefte für den Disput über Wissen* 27: 38–42.

———. 2012b. "Experiment, Forschung, Kunst." *Dramaturgie* 2/12: 11–14.

Rickli, Hannes, ed. 2011. *Videogramme: die Bildwelten biologischer Experimentalsysteme als Kunst- und Theorieobjekt / Videograms: The Pictorial Worlds of Biological Experimentation*. Zürich: Scheidegger & Spiess.

———. 2012. "Precarious Evidence: Notes on Art and Biology in the Age of Digital Experimentation." In *Intellectual Birdhouse: Artistic Practice as Research*, edited by Florian Dombois, Claudia Mareis, Ute Meta Bauer, and Michael Schwab, 101–15. London: Koenig Books.

Schatzki, Theodore R., Karin Knorr Cetina, and Eike von Savigny, eds. 2001. *The Practice Turn in Contemporary Theory*. London: Routledge.

Schenker, Christoph, and Hannes Rickli. 2012. "Experimentation." In *Praktiken des Experimentierens: Forschung und Lehre in den Künsten heute / Practices of Experimentation: Research and Teaching in the Arts Today*, edited by Christoph Brunner and Giaco Schiesser, 146–59. Zurich: Scheidegger & Spiess.

Schmieder, Falko. 2010. "'Experimentalsysteme' in Wissenschaft und Literatur." In *Experiment und Literatur: Themen, Methoden, Theorien*, edited by Michael Gamper, 17–39. Göttingen: Wallstein.

Schwab, Michael. 2009. "First, the Second: The Supplemental Function of Research in Art." In *Art and Artistic Research: Music, Visual Art, Design, Literature, Dance / Kunst und künstlerische Forschung*, edited by Corina Caduff, Fiona Siegenthaler, and Tan Wälchli, 56–65. Zurich Yearbook of the Arts 6. Zurich: Zürcher Hochschule der Künste / Scheidegger & Spiess.

———. 2011. "Editorial." *Journal for Artistic Research* (*JAR*) 0. Accessed 30 June 2013. http://www.jar-online.net/index.php/issues/editorial/480.

———. 2012a. "Between a Rock and a Hard Place." In *Intellectual Birdhouse: Artistic Practice as Research*, edited by Florian Dombois, Ute Meta Bauer, Claudia Mareis, and Michael Schwab, 229–47. London: Koenig Books.

———. 2012b. "Exposition Writing." In *Yearbook for Artistic Research and Development*, 16–26. Stockholm: Swedish Research Council.

———. 2012c. "The Research Catalogue: A Model for Dissertations and Theses." In *The Sage Handbook of Digital Dissertations and Theses*, edited by Richard Andrews, Erik Borg, Stephen Boyd Davis, Myrrh Domingo, and Jude England, 339–54. London: Sage.

Shapin, Steven. 1984. "Pump and Circumstance: Robert Boyle's Literary Technology." *Social Studies of Science* 14 (4): 481–520.

Shapin, Steven, and Simon Schaffer. 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.

Stravinsky, Igor. (1942) 1970. *Poetics of Music in the Form of Six Lessons*. Translated by Arthur Knodel and Ingolf Dahl. Charles Eliot Norton Lectures, 1939–40. Cambridge, MA: Harvard University Press.

A Theory of Experimentation in Art?

Reading Kubler's History of Art after Rheinberger's Experimental Systems

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For the art of the 1950s and the 1960s, one of the most central keywords was "experiment." How else should one understand the groundbreaking works of John Cage, or the development of Fluxus and happenings, if not as the spirit of advanced experiment and as a break with tradition? Experiment was not only a synonym for an orientation towards the new, it was also equivalent to awakening, progress, and—from today's standpoint, perhaps most irritatingly—an engagement with society. From an art historical perspective, artistic experiment is closely linked with the avant-garde and the dissolution of boundaries in the arts of the twentieth century, which in the meantime have become historic and museum-like, traditional themselves. Recent research work suggests that the experimental methods of the nineteenth century became a successful instrument in both the positivistic sciences and the modern arts, which, delimiting the past, aimed now at renewal and change (Gamper 2010).

Despite this history of experiment in artistic discourse, it is unclear what the term exactly means in artistic practice. Frequently the experiment appears to imply a meta-reflection on a relation to the sciences, which, depending on historical context and artistic intention, can tend to differentiation or to convergence. Since the Second World War, there have been many conscious references to experiments, made in order to strike a bridge between the arts and sciences. An example of this is the philosophy of technology of the scientist and novelist Max Bense, who held the artistic reflection of insights from the natural sciences and engineering to be a requirement of the time, and who constructed his theory based on artistic experiment (Bense [1965] 1997).

Another example of the experimental as a mediating concept is the American group E.A.T. (Experiments in Art and Technology), which was founded in New York in 1967 after a successfully realised series of multimedia happenings and

performances. The group made the artistic application of the newest technologies their programme, and with its institutionalisation wanted to create the basis for a long-term cooperation between artists and engineers. The group's name makes clear that the common overlap for a cooperation of this sort was seen to lie in the technological and materials aspects of experimental practices.

As a mediating point of reference, experiment also plays an important role in the history and theory of the sciences and the arts. That, at least, is suggested by the reciprocal references and roaming arguments that one can discover in essays on the history of science, aesthetics, and art history. The present essay will look more closely at one example of this. The point of departure is given by Hans-Jörg Rheinberger's 1997 historiographic treatise on protein synthesis research, in which he developed his theory of "experimental systems" and "epistemic things." In this book about the procedures and modalities of natural scientific experimentation, there are several reflections on the relationship between art and science. One book in particular is cited repeatedly by Rheinberger in this context: the theoretical essay *The Shape of Time: Remarks on the History of Things* by the American art historian George Kubler, which was first published in the United States in 1962 and has since received numerous translations. Rheinberger emphatically pointed out the topicality of this text a few years ago in the German art journal *Texte zur Kunst*. There, he pays tribute to Kubler as a "structural thinker" and names him in the same breath as the post-structuralist philosophers Michel Foucault and Jacques Derrida—an accolade unusual for an art historian (Rheinberger 2009, 109). Against the backdrop of current interest in the arts in Rheinberger's theory of science, it seems only reasonable to go back to the author's references to the arts and submit Kubler's text to a new reading from this perspective. Kubler has yet to receive attention in the debates on artistic research, even though Rheinberger's analysis of his theory indicates that it could be more relevant to artistic research than this lack of interest would suggest.

RHEINBERGER'S READING OF *THE SHAPE OF TIME*

In the above-mentioned article, Rheinberger explained the extent to which Kubler's essay had influenced his conception of the history of science and how he initially encountered this art historical text from the 1960s. He first read the book while preparing for a research fellowship at Stanford University, during which he initiated his reorientation from the science laboratory to historical reflection about this type of practical knowledge. He describes his reading experience in retrospect with uncommon emotion with the words: "Kubler's book then struck me as strangely inspiring, even electrifying" (Rheinberger 2009, 109). This enthusiasm can perhaps be explained in that the other domain, on which Kubler's argument is based, helped Rheinberger to visualise more clearly the lines of connection to his own research interests, perhaps more than could have been done by an essay oriented to natural science. Similarly, artists today find inspiration in Rheinberger's books and recognise in his descriptions of natural science experiments the principles of their own artistic practice.

There are two characteristics that have contributed to the success of Kubler's book even outside specialist academic circles—important also for Rheinberger. For one, there is the gripping language. Even today, one can be seduced by the poetic overtones of this seemingly jotted-down essay, which is able to link profound reflections on the history of science with vivid metaphors. The metaphorical passages have been cited time and again—for instance, the comparison of the historical artwork with a star, still just visible, but actually already gone out; or the description of artistic activity as quest in the darkness of a mine—an image also taken up by Rheinberger (1997, 75). There is also, on the other hand, a generally held viewpoint that does not get caught up on particular problems of art history as an academic discipline but rather raises itself to the level of the history of science, thereby thematising the possibilities and limits of art historical writing.

In Rheinberger's book on "experimental systems," there are not only repeated references to but also extensive quotes from Kubler's text (Rheinberger 1997, 4, 75, 80, 178, 180). However, it is striking that there is only one case in which Rheinberger comes close to speaking about a concrete term that Kubler employs, namely the "sequence." Otherwise, he refers in these passages to epistemological problems, which he identifies as following on from Kubler but then, inspired by French post-structuralism and epistemology, develops further.[1] Kubler's text doesn't exactly deliver Rheinberger any ready-made solutions that he could borrow for his purposes. Instead, it offers him occasions to deepen his own interrogations and trains of thought.

All in all, one can discern four aspects in Kubler's book that Rheinberger highlights. In the following I would like to summarise as briefly as possible Rheinberger's commentaries on The *Shape of Time* and the references to his own research, in order to make clear the direction of the interpretation. Initially Rheinberger highlights the differentiated treatment of cultural development processes in Kubler's text. Kubler avoids the use of terms borrowed from biology in his description of historical time. Instead, he tries to describe the forms of cultural time, or rather the possibilities of thinking about cultural time (Rheinberger 2009, 109–10). For Rheinberger, too, the idea of cultural time, in the sense of the immanent time of experimental systems, plays an important role. Thus he strives to define the specific time structure of work-and-process units of natural science experimentation—for example, in the laboratory of a molecular biological research group. For Rheinberger, this is characterised by the specific logic of afterwardsness, which he calls "historicality": on the one hand the scientific outcome leads to retroactive interpretations of prior events, which never happened as a so-designed relation; and conversely, practices in the present receive another status, in that they are treated as a future past of an outcome that is yet to happen (Rheinberger 2009, 177–78).

Second, Rheinberger points to the strong association of the shape of temporality with the materiality of things; for Kubler works on a history of things, which captures historical time by means of the relations of surviving things

1. For his arguments on historical epistemology, see Rheinberger (2010).

(Rheinberger 2009, 109, 111). Rheinberger's research interest is very similarly oriented on scientific developments captured not by their accompanying theories, but rather by their material traces and the processes in the laboratory. He is interested in the knowledge embodied in things (Rheinberger 1997, 4). This point of view lets him designate all this, which is not yet known, and for which the efforts of the research apply, as an epistemic thing, although it could likewise be structures, reactions, or functions (Rheinberger 1997, 28).

Third, Rheinberger finds in Kubler's text a parallel between art and science, in regard to how the new originates in these fields. That does not mean that Kubler ignores the differences between art things and science things. But the processes by which these things are brought about are comparable for him; in both spheres innovation is not the product of a brilliant plan, but rather the perception of one option in an existing framework, which is given through earlier artworks (Rheinberger 2009, 110). Rheinberger invokes Kubler as much as Thomas S. Kuhn in order to emphasise the principally open character of experiment. In experimental research, new insights cannot be produced by orientation towards a goal, but only in the recognition of possibilities ensuing from pre-existing processes. Concrete questions and answers are clarified only by passing through a whole system of experiments and controls. Innovation is more the product of chance or a by-product of the process of repetition than it is an invention already intended beforehand (Rheinberger 1997, 27–28, 75).

The fourth and last point in Rheinberger's interpretation is aimed at the concrete description of such development processes. Kubler introduced the concept of the sequence to be able to reconstruct cultural developments properly. According to Kubler, the sequence is a succession of things that are related as solutions to similar artistic problems. The prevalence, repetition, and variation of things in the sequence can be observed over long periods and can, in contrast to a linear conception of time, take irregularities and discontinuities into consideration (Rheinberger 2009, 111). Rheinberger draws a direct comparison between Kubler's concept of the sequence and his own version of experimental systems with respect to the argumentative interrelation between materials and temporal development. Experimental system and sequence explain innovation as a process of differential reproduction that is characterised by repetition and variation. Rheinberger alludes also to a fundamental difference, in that Kubler's sequence is oriented towards macrostructures rather than the microstructure of the experimental systems. Moreover, he finds too narrow Kubler's proposal that the sequence be defined by consistent problems and their solutions. For Rheinberger highlights the contingency of the scientific research process, whilst explaining the object of knowledge as provisional and ambiguous—a dimension which is missing in the perspective of problem solving. In an experimental system, it can be the case that the epistemological thing changes, and with it the research problem, without this having to lead to breaks in the material processes of experimentation within the system (Rheinberger 2009, 111).

In particular, the comparison between the experimental system and the sequence makes one curious about Kubler's theory. Is it really, as Rheinberger argues at the end of his article in *Texte zur Kunst*, a "milestone" in the history of

science regarding fundamental orientation towards concrete material? Which connections to artistic practice can be established here, and does the essay possibly contain even a discrete theory of artistic experimentation? The following paragraphs will go closer into Kubler's art historical theory and the sequence model, in order subsequently to build a bridge to artistic experimentation.

George Kubler's Art History and Artistic Experimentation

Kubler's structuralist art history puts the preserved material culture at the centre of consideration. The theoretical valorisation of things as a consequence of this was quite unusual in the period when the book was published. Customarily, cultural theory at the time devoted itself to the observation of things as signs or the decoding of their symbolic function (Baudrillard 1996). In contrast, Kubler was much more interested in the meanings that things develop between themselves in their relations to one another. Already his first sentences, which are accommodatingly formulated as an intellectual game, impart the radical aspiration of the text: what happens if we suppose that the idea of art can be expanded to embrace the whole range of human-made things? (Kubler 1962, 1) From today's standpoint it is easier to recognise how much this desire for a widened subject area corresponds to the development of art in the postwar period. Thus, in the same way that Fluxus and happenings, performance, and pop art extended the concept of art, Kubler broadened the scope of art history.

In his own research interests, Kubler did not have an immediate affinity with contemporary art, although he certainly followed the reception of his essay in the art scene and showed himself in interviews to be open to questions on the actuality of his deliberations (Kubler 1985). His research interests encompassed South and Central American art, including the ancient cultures of Central America, the connections between indigenous and European traditions during the colonial era, and acculturation in the modern age. In his student days in the 1930s, during which he studied under émigré art historians Henri Focillon and Erwin Panofsky, among others, he was already occupied with the architecture of New Mexico (Kubler 1940). Kubler thus devoted himself to topics that until then art history had given little attention, and he soon realised that he would have to modify methods that had been developed in the area of European culture. That is the background for Kubler's essay, which relativised established methodical approaches like the history of style, iconology, and the history of biography, and also pulled the rug from under the myths of the singular masterpiece and the artist as genius. Instead, Kubler adopted an interdisciplinary approach, by adapting methods and insights from other academic fields—for example, anthropology, mathematics, linguistics, and information theory (Kubler 1962, 4, 10–12, 68–71).

For Kubler, things become relevant because they make it possible to unite the material and mental aspects of art under the generic term "form" (Kubler 1962, 9). This accords well with Rheinberger's inclination to think of

knowledge production in the laboratory as an indissoluble fusion of things and concepts, though Kubler's position in art has a completely different direction and impact. Rheinberger's much later reflection is influenced by post-structuralism, and he argues that representation is always an intervention in reality (Rheinberger 1997, 102–13). In contrast, Kubler's research occupies the overlap between art history and art anthropology, so that the conceptual connection of ideas and materials in form serves also to transverse the normative boundaries between high and low art and between European and non-European art. His strong notion of form nevertheless seemed to fit in readily with the tradition of art history and led to the fact that his theory was soon seen as outmoded by 1970s critics of formalism. This notion has changed with newer theories about things and artefacts, which focus on things as agents, alongside Bruno Latour (2005), Alfred Gell (1998), and W. J. T. Mitchell (2005). With Kubler there are a number of aspects that, very similarly, are aimed at the agency of things: for example, when he attributes the preserving and replication of things to desire, in the sense of power to affect people (Kubler 1962, 1); or when he considers human beings as intermediaries for the dissemination of things in time and space (62); or when he explains the creation of forms as an involuntary act of command mediated by artworks (108). One can thus justifiably regard Kubler's essay as an early theory of things in art history (Maupeu, Schankweiler, and Stallschus 2011).

The formal sequence is perhaps the most important idea in Kubler's essay. It undertakes to make the relations between things describable. On the one hand, it serves Kubler as an instrument to sort and classify things, and it replaces for him the sharply criticised art historical periodisation according to styles. The term "sequence" is borrowed from mathematics, and Kubler thereby radically turns away from older biological models for the explanation of historical processes, above all to circumvent the normative discourse around early and late stages of development. On the other hand, the sequence gives him the leverage to treat inventions not as isolated events but rather as positions linked to one another, so that they are made accessible to historical reflection. Kubler does not question that radical innovations, which he calls "prime objects," could of course happen and lead to greater change. But his focus is on their potency within the sequence and on historical drift over long periods (Kubler 1962, 39–45; for a critical consideration of Kubler's prime object see Shalem 2011).

A prerequisite for Kubler's thinking about the history of art in sequences lies in the problem-oriented conception of the artwork as the expression of artistic action. In this perspective every meaningful artwork appears as a "hard-won solution to some problem" (Kubler 1962, 33). And for each artwork as problem-solution, preceding or following solutions can be found, so that they constitute for the art historian an interrelated chain of solutions: the sequence. Kubler explains his category of problem solving with the example of a technical requirement, the implementation of ribbed vaulting in Gothic architecture (Kubler 1962, 36–37). But all in all, the nature of the problem remains relatively undefined and therefore open to future applications. Moreover, Kubler makes it clear that each individual artwork contains a cluster of traits and thus can be

assigned to different sequences according to the problem being considered. Dwindling interest or external circumstances can lead to interruptions in the sequence or even bring it to a standstill. But a sequence can also, as a potentially open category, be continued under other conditions hundreds of years later. In other words, for the sequence there are no cultural or temporal barriers, no genus-specific or media borders (Kubler 1962, 34–39, 106–9).

A last important point in Kubler's theory concerns the construction of history as an interminable process in interaction with the preserved material culture. According to Kubler, time makes itself felt—apart from direct experience in the instant of actuality—only in signals (Kubler 1962, 17). The knowledge of the past relies on the transmission of signals, which were sent in the there and then and are received in the here and now. Thus, Kubler gives a media-theoretical interpretation of history and stresses, with terms borrowed from information theory, the mediated character of every cultural tradition. Signal transmission is a complex process and susceptible to faults, due to the multiple transformations that occur on the way from transmitter to receiver. Further, the receiver of a historical message can become a new transmitter, a process that Kubler compared to the function of a relay (Kubler 1962, 21–24). From this perspective, history equates to a technical apparatus of transmission and translation.

What has all this to do with artistic experimentation? Rheinberger's examination of Kubler makes clear that *The Shape of Time* provides all the necessary terminology to enable a differentiated approach to artistic experiment. The experimental system as the functional unit of science corresponds to Kubler's sequence as the structuring unit of artistic development. Rheinberger's distinction between epistemic things as materialising questions and technical things as knowledge bases can be set parallel to Kubler's analytic delimitation of artistic problems from realised solutions that define the further scope of artistic production. Concrete applications will have to prove how productive this framework is for thinking in the domain of contemporary art.

Although Kubler rarely explicitly uses the term experiment, he makes it the actual backbone of his argument. Kubler describes the formal sequence as a sorting category, which makes "the linked procession of experiments" comprehensible in art (Kubler 1962, 85). Very much like Rheinberger, he points out similarities between the arts and sciences relating to how innovations occur in both domains. New forms in art result from an artistic searching process, which must only seldom be visible in the artwork: "perhaps the jottings and sketches of architects and artists, put down in the heat of imagining a form, or the manuscript *brouillons* of poets and musicians, crisscrossed with erasures and corrections, are the hazy coast lines of this dark continent of the 'now,' where the impress of the future is received by the past" (Kubler 1962, 18). Artistic experimentation is the driving force behind the development of forms, a premise that Kubler takes from the French art historian Henri Focillon. Kubler not only studied with him and cited him as his most important teacher but also translated into English his monograph *La vie des forms*, with which his own essay is affiliated to some degree (Ducci 2014).

Kubler gives this production-aesthetic notion of the development of forms a special twist by removing himself from the consideration of individual artworks and artists. If one casts one's mind back to the quote from Kubler (above) on the connection of sequence and experiment and if one then reverses the perspective, starting from the material heritage, one could also say that from the succession of things it is possible to read a continuous experimental form. And to characterise it more closely, Kubler extensively describes the most common patterns of such continuous forms: alterations in artistic forms can proceed quickly or more slowly; change can take place abruptly or gradually due to repetition and variation, whereby accident then also plays a role (Kubler 1962, 84–96); in addition, one can observe interruptions, blockades, and conscious revivals of artistic problems (Kubler 1962, 106–21). In this sense, Kubler's theory offers a wide spectrum of conceptual tools and arguments that can be applied to artistic experimentation.

However, as Rheinberger has already emphasised, Kubler above all takes historic macrostructures into account, so that one cannot use his work directly in connection with individual contemporary art production, but must accordingly customise and convey it. That leads to a question: Wherein consists the surplus value of Kubler's perspective for contemporary art?

KUBLER'S RECEPTION IN CONTEMPORARY ART

On its publication in the 1960s, Kubler's essay was avidly taken up by the American art scene. Minimal and conceptual art favoured a formalistic reading, so artists like Robert Morris could refer to Kubler to argue for the radicalisation of forms of expression (Dreher 1998). But also Kubler's conception of history, which in a poststructuralist way departed from chronological time and which sets entropy in the place of progress, found great resonance with the likes of John Baldessari and Robert Smithson (Lee 2004, 218–56).

Since then the interpretations of Kubler's essay in contemporary art discourse have changed considerably. And, interestingly, there has been a stronger reception in the last few years, which could prove insightful with respect to the debates about artistic research. The artist Ellen K. Levy (2009) has interpreted Kubler's theory against the backdrop of the interdisciplinary field of research on complex systems. In her article, she not only draws attention to explicit and implicit connections to natural science; as part of an argument for Kubler's relevance, she also gathers numerous examples of artistic works that are targeted towards a portrayal or simulation of temporal processes and historical change. For her, Kubler's essay provides the theoretical equipment to think about art production as a "three-way conversation among art, science, and technology" (Levy 2009, 88).

The Iran-born and Berlin-based artist Ashkan Sepahvand has a very different interest in Kubler's essay. His art project *Other Than Someone, There Was No One*, from 2010, is participatory art as well as a literary experiment. It begins with a concrete setting, the National Museum in Beirut. From group discussions there with archaeologists, artists, and museum visitors about the exhibited objects, he

develops a fictional dialogue that fathoms the possibilities of alternative narratives, as opposed to the official narrative of the museum (Sepahvand 2010). The resulting text draws attention to the fractures in discourse in the varied history of Lebanon with respect to material continuities. But it is also about a general negotiation with history, about institutionalised remembering and forgetting, and about the impact of historical gaps. In the text, a first-person perspective is repeatedly taken, with terms and models from Kubler's essay. Sepahvand has stressed in an interview the great importance of Kubler not only for this project but also for his artistic output in general (Sepahvand 2011).

A third example of the contemporary reception of Kubler's essay is a Simon Starling exhibition. In the neo-conceptual works and film installations of this British artist, concrete things are common starting points, in order to thematise past presents and social situations of change. To this end, things are taken apart, reconstructed, recycled, and set together in new ways. These transformations are embedded in narratives, so that the symptomatic relations to other things and places become perceptible. In 2010, Starling was invited to rearrange the collection of the Camden Arts Centre in London and through doing so to recall the history of the institution. Starling reconstructed past exhibitions and situated thirty artworks at exactly the places at which they were earlier presented to the general public. In addition, new works appeared that were supposed to provoke a contemporary reading of the older artworks. In the texts accompanying the exhibition, Starling quoted from Kubler's essay in order to make clear that actuality is a relative point of reference and dependent on the viewer, who permanently reconfigures past, present, and future in relation to one another (Camden Arts Centre 2010).

These three examples give an initial impression of the range of artistic positions that employ Kubler's essay. Against this backdrop, I would like to point out two aspects, above all, which make Kubler's theory interesting again today. On the one hand, Kubler's theory draws attention to the perception of constellations of things dependent on (historical) time. His principal focus, on transmission through time and the resultant dynamics, substantially distinguishes his theory from other theories of things and praxeological scientific theories that are designed for the description of the social rather than the historical (Latour 2005, 1–20). Kubler explicitly describes an art history that is constituted in sequences as a mesh or network (Kubler, 37–38, 121–22). This temporal-historical accentuation of a theory of things conforms to like developments in visual art, which have led to an emphasis on the character of events, for example through the use of time-based media and the orientation to performance, happenings, and participatory situations in the widest sense.

On the other hand, Kubler's concept of sequence makes possible a treatment in which the things can become the starting point for a multiplicity of histories. There is a humanistic kernel in Kubler's history of art, and it is fed by his refusal of any ideological use of art and culture. In his conception, traditions may be understood as influential but plural and open in their interpretation for the present day. The sequence can bring together artistic works from very different contexts, avoiding the normative implications of comparative

examination. This is an aspect that, in light of the global alignment of art production, is steadily gaining importance, and which qualifies as a basis for a definition of artistic experimentation.

Against this one could hold that Kubler's strong conception of form is evidently problematic, because the renewal of form has lost its justification since modernism. But there are indications that only the idea of artistic forms and their function has changed fundamentally. Nicolas Bourriaud has argued that form in contemporary art practice has become a dynamic and ephemeral structure. Artists no longer seek a stable and ultimate form; rather, the transition of forms and the shifts among various media formats have moved to centre stage (Bourriaud 2009, 79, 131–42). What could be closer to Kubler's art history than such a dynamic conception of artistic form? But Bourriaud also intimates that the interplay between form, production, and reception deserves more attention than Kubler gives it, because "the aura of art no longer lies in the hinter-world represented by the work, nor in form itself, but in front of it, within the temporary collective form that it produces by being put on show" (Bourriaud 2002, 61). Nevertheless, Kubler's notion of form seems not to have lost any of its originality, perhaps because he doesn't come from philosophical aesthetics, but is rather, through Focillon, influenced by the philosophy of Bergson. His temporal definition of form opens his theory to contemporary art production in its orientation towards performance, processuality, and experiment. To conclude by returning to the opening question: Kubler's essay doesn't provide a theory of artistic experimentation in a profoundly epistemological and methodological fashion, but his sequence theory of the history of art contains a theory of experimentation in art that can to some extent be developed on the basis of Rheinberger's reading.

REFERENCES

Baudrillard, Jean. 1996. *The System of Objects*. Translated by James Benedict. London: Verso. First published 1968 as *Le système des objets* (Paris: Gallimard).

Bense, Max. (1965) 1997. "Kunst und Intelligenz." In *Ausgewählte Schriften, Band 1: Philosophie*, edited by Elisabeth Walther, 350–61. Stuttgart: Metzler.

Bourriaud, Nicolas. 2002. *Relational Aesthetics*. Translated by Simon Pleasance and Fronza Woods with Mathieu Copland. Dijon: Les Presses du réel.

———. 2009. *The Radicant*. Translated by James Gussen and Lili Porten. New York: Lukas & Sternberg.

Camden Arts Centre. 2010. Press release on the exhibition *Never The Same River (Possible Futures, Probable Pasts)* selected by Simon Starling. London: Camden Arts Centre. Also published online by *New Exhibitions*. Accessed 24 October 2011. http://www.newexhibitions.com/uploads/upload.000/id17474/press_release.pdf.

Dreher, Thomas. 1998. "Allan Kaprow versus Robert Morris: Ansätze zu einer Kunstgeschichte als Mediengeschichte." Thomas Dreher Intermedia Art. Accessed 28 November 2012. http://dreher.netzliteratur.net/1_Kaprow_vs_Morris.html.

Ducci, Annamaria. 2014. "'We Need to Write History as Layer-Cake History': Kubler and Focillon at Yale, January 1940 (Starting from Some Manuscript Notes)." In *Im Maschenwerk der Kunstgeschichte: Eine Revision von George Kubler's The Shape of Time*, edited by Sarah Maupeu, Kerstin Schankweiler, and Stefanie Stallschus, forthcoming. Berlin: Kadmos.

Gamper, Michael. 2010. Introduction to *"Wir sind Experimente: wollen wir es auch sein!": Experiment und Literatur II: 1790–1890*, edited by Michael Gamper, Martina Wernli, and Jörg Zimmer, 9–23. Göttingen: Wallstein.

Gell, Alfred. 1998. *Art and Agency: An Anthropological Theory*. Oxford: Oxford University Press / Clarendon Press.

Kubler, George. 1940. *The Religious Architecture of New Mexico in the Colonial Period and since the American Occupation*. Colorado Springs: Taylor Museum.

———. 1962. *The Shape of Time: Remarks on the History of Things*. New Haven, CT: Yale University Press.

———. 1985. "A Talk with George Kubler: An Interview by Robert Joseph Horvitz." In *Studies in Ancient American and European Art: The Collected Essays of George Kubler*, edited by Thomas F. Reese, 413–17. London: Yale University Press.

Latour, Bruno. 2005. *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford: Oxford University Press.

Lee, Pamela M. 2004. *Chronophobia: On Time in the Art of the 1960s*. Cambridge, MA: MIT Press.

Levy, Ellen K. 2009. "Classifying Kubler: Between the Complexity of Science and Art." *Art Journal* 68 (4): 88–98.

Maupeu, Sarah, Kerstin Schankweiler, and Stefanie Stallschus. 2011. "'Die begehrenswerten Dinge': Kunstgeschichte nach George Kubler." *Kritische Berichte* 39 (3): 75–86.

Mitchell, W. J. T. 2005. *What Do Pictures Want? The Lives and Loves of Images*. Chicago: University of Chicago Press.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

———. 2009. "History of Science with George Kubler." *Texte zur Kunst* 19 (76): 109–12.

———. 2010. *On Historicizing Epistemology: An Essay*. Translated by David Fernbach. Stanford, CA: Stanford University Press.

Sepahvand, Ashkan. 2010. *Other Than Someone, There Was No One*. Beirut: published by the author. Also published online by *ArtTerritories*. Accessed 24 October 2011. http://www.artterritories.net/wp-content/uploads/2011/01/Other-than-someone-there-was-no-one1.pdf.

———. 2011. "Interview with Ashkan Sepahvand by Nat Muller." *ArtTerritories*, January 24. Accessed 24 October 2011. http://www.artterritories.net/?page_id=1716.

Shalem, Avinoam. 2011. "Histories of Belonging and George Kubler's Prime Object." *Getty Research Journal* 3: 1–14.

Electrical Images

Snapshots of an Exploration*

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I did not consciously go in search of either electricity or its infrastructures as the subjects of my artistic preoccupations. But at some point they came to perturb, as a resistance of sorts, the images with which my work is concerned. This resistance emerged gradually, during a period in which the images preoccupying me were becoming increasingly elusive. Something undefined permeated the visual material and thereby unsettled my usual approach to it. So, long before I managed to address the phenomenon of electricity on its own terms, its effects had begun to spread and to destabilise my perception of these images. Facing what had become an uncertain situation, I tried to reorient my work and began engaging in exploratory experimentation. By "exploratory experimentation" I mean search operations undertaken in unfamiliar terrain, with a view to gaining one's bearings and possibly discovering new kinds of order.

To trace some of the characteristics of such experimentation, this paper discusses some selected snapshots from the early phases of my research, which is still under way at the time of writing. Let me establish two of these characteristics from the start: first, such exploration must proceed, at least provisionally, without any specific guiding questions, concepts, or theories; instead, it actually helps develop questions and concepts. Second, during the search process, the process of selecting moments in which something apparently crucial is occurring happens blindly, because at that point it is impossible to determine whether an object or phenomenon that one happens upon or that happens to one fits into a scheme in which it might become important. Only retrospectively and from a certain distance might certain aspects crystallise into a topic that has the semblance of careful advance planning and composition. But I have not yet reached that stage. So, for now, I am guided—or perhaps enticed—by speculation, sometimes even by sheer feeling or intuition, when pursuing one line of enquiry and shunning another.

The snapshots discussed below are illustrated by a series of photographs that document in diary form what are mostly technical objects and processes. The

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illustrations reflect the origins of my research interest, touch upon emerging research questions, and outline the various stages of action taken.

VIDEOGRAMS OF EXPERIMENTATION

Before discussing my work-in-progress, let me return to its starting point, its premises, and, to use a computer metaphor, its default settings (since I did not begin from scratch). Over the past two decades, I have amassed an unsystematic collection of audio-visual materials left over from experiments carried out in behavioural biology laboratories. It all began with a videotape that I received on a chance visit, made for personal reasons, to a research laboratory in 1991. From that point, my collection grew on an infrequent but nevertheless steady basis, because researchers at other laboratories passed on material to me. The video and audio recordings of experiments performed to observe and measure fish and insect behaviour were stored on differently formatted magnetic tapes up until about the mid-1990s and on digital storage media increasingly thereafter. Once the experimenters had sifted through and selected the scientifically relevant data, they left the discarded raw material, or what biologists refer to as raw data, to me. For me as an artist, the unusual frames of these serial images, their particular dramaturgy, and the gestures appearing therein were truly fascinating. But because I lacked any classificatory means, the recordings remained curiously silent and failed to speak to me. At first, Hans-Jörg Rheinberger's book *Experiment, Differenz, Schrift* (1992) helped me consider the recordings as "traces" of experimentation; later, inspired by the work of Bruno Latour (1993), I construed the material as "inscriptions." What was initially a purely aesthetic stimulus thus became enriched with questions of substance, which permitted me to adopt a critical approach to the material.

Several years later, in 2007, and following numerous attempts to implement the found footage in video installations, I initiated a research project entitled "Spillover: Videograms of Experimentation."[1] This project enabled our research team to sift through hundreds of hours of analogue recordings and several thousand hours of digital ones, to log extracts from the collected sequences, and to rework the selected material into a digital archive. "Spillover" was undertaken in association with three partner laboratories under the direction of Philipp Fischer,[2] Hans Hofmann,[3] and Steven N. Fry respectively.[4] Besides these image producers, the project also involved science studies scholar Christoph Hoffmann, sociologist Michael Guggenheim, and art historian Nicola Müllerschön. Workshops convened at the various laboratories were dedicated to discussing key concepts, such as "experiment," "trace," "date," and "image," from different disciplinary perspectives.

1 Institute for Contemporary Arts Research (IFCAR), Zurich University of the Arts (ZHdK); for project details, see Institut für Gegenwartskunst (2013b). "Videograms of Experimentation" ran from 2007 to 2009 and was funded by the Swiss National Science Foundation (www.snf.ch).

2 Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Biological Institute Helgoland.

3 Section of Integrative Biology, University of Texas at Austin.

4 Institute of Neuroinformatics, Swiss Federal Institute of Technology (ETHZ) and Zurich University.

Various findings emerged from exploring the audio-visual surplus of behavioural experiments. From one perspective the recordings could be regarded as signatures of the self-registering media employed in experimental practice, signatures that brought to the fore both the material conditions and the temporal dynamics of the various experimental processes. The laboratories in which the experiments were carried out, the lighting conditions, and the manifold interactions between researchers, laboratory animals, and video facilities not only established a framework for concrete research activity but also functioned as its protagonists. These interactions became evident in the negotiations and reciprocal exchanges between human, animal, technological, and media actors, whose agency was couched largely in aesthetic terms. Besides the specific spatio-temporal conditions, the aesthetic manifested itself in the endless processing of the material and temporal resistance of those involved, and it thus included moments of failure and realignment. "Spillover" provided insight into the various phases of (empirical) research practice that precede the subsequent generation, correlation, calculation, and publication of the obtained sets of data. On the basis of the raw data, the process of scientific abstraction, briefly put, eliminates all material, specific, and singular features from the original material.

These utility films, that is, films for practical use, contain a surplus of signs that extends beyond intentional, laboratory-based data collection. The ambiguity at work here reveals the "two-facedness" of empirical research practice. The French geneticist and historian of science François Jacob distinguishes between "day science" and "night science." He observes that "night science wanders blind. It hesitates, stumbles, recoils..." By contrast, "day science" presents itself as a "formal arrangement... as admirable as that of a painting by da Vinci or a Bach fugue" (Jacob 1998, 126). In the "videograms," as I call the audio-visual, multi-level, sign-bearing vestiges of scientific experimentation, unintended messages are more intimate and include the phases of "night science," which normally remain inaccessible to outsiders.

Our project analysed and interpreted such videograms from the perspectives of science studies, sociology, art and media studies, and art. These different perspectives had equal status in the project, thus creating a multi-perspective view of biology utility films. My artistic study put to use the aesthetic potential of the laboratory leftovers in various exhibitions, in order to cast a different light on research practice and to make such practice negotiable from new, hitherto unexplored angles. The study thus enabled a differentiated perspective on the manifold interrelations existing between the project participants' artistic and research practices. (Notably, these interrelations can assume highly diverse forms in different contexts; those discussed here should therefore not be generalised for either the arts or the sciences.[5])

5 For a summary and discussion of results, see Rickli (2011). Exhibitions: *Hannes Rickli: Videogramme*, Helmhaus Zürich 2009 (www.helmhaus.org); *Hannes Rickli: Kunst mit Experimentalsystemen*, Kunstmuseum Thun (http://www.kunstmuseumthun.ch). International conference: *Latente Bilder: Erzählformen des Gebrauchsfilms*, Collegium Helveticum ETH Zürich 2009 (see Institut für Gegenwartskunst 2009).

MISSING LEFTOVERS?

The historical source material of the videogram archive and its treatment in the "Spillover" project are helpful in tracing the growing digitisation of research practice in behavioural biology. This field has so far largely resisted digitisation when compared to other sciences such as particle physics, meteorology, and climate research. A key driver of this development is the use of media as instruments in experimental systems. The increasing availability and technological development of analogue consumer-level devices during the 1970s and 80s enhanced the possibilities for the videographic and auditory observation and measurement of animal behaviour. Thus, images recorded over extended periods of time, together with more image details provided by higher resolution, generated ever-larger amounts of data, which resulted in automated evaluation supplanting manual routines. A parallel development involved the digitisation of recording techniques, which by the late 1990s entailed the comprehensive digitisation of almost every intermediate step (from data collection and evaluation through the correlation and calculation of data sets to publication). Of significant import for my artistic project is the delegation of decision-making about the relevance of data to computerised data processing and the concomitant automatic deletion of (purportedly) irrelevant data. Such selection preforms data storage and thus prevents me from rediscovering the unintended, the ambivalent, and the ambiguous moments in this material that might be of use to art. From an artistic perspective, the technological developments outlined above raise a basic question: do any vestiges of experimentation, whose forms are unknown to me, perhaps remain in raw form somewhere in the digital machinery and processes?

To explore such possibilities, my current project, "Computer Signals: Art and Biology in the Age of Digital Experimentation,"[6] focuses on the various technical devices used for data processing (computers, switches, converters, radio transmitters, etc.). My interest now is less in the informatics and signal processing involved than in the aesthetics. One aesthetic quality of computers and processors, which are black boxes to me, is their perceptible materiality. The material dimension also includes the physical surroundings of such hardware, as well as the infrastructure required for performing the "digital" work inside a device's casing. Thus I am shifting attention from the reading of images to rendering perceptible the processes operative within the image-creating apparatuses.

6 Institute for Contemporary Arts Research (IFCAR), Zurich University of the Arts (ZHdK). For project details, see Institut für Gegenwartskunst (2013a). The project is scheduled to run from 2012 to 2015 and is being funded by the Swiss National Science Foundation. Besides biologists Philipp Fischer and Hans Hoffman, project partners include Gabriele Gramelsberger, a philosopher of science at FU Berlin and Cologne Academy of Media Arts (see also her chapter in this book), and Christoph Hoffmann, a historian of science at Lucerne University.

REMOS1, STARTING DATA TRANSMISSION FROM THE ARCTIC SEA

My first visit to *RemOs1* (Remote Observation System), an underwater observation platform located in Lake Constance near the town of Constance, came in the summer of 2005. The platform and the fish ecology research team under Philipp Fischer have since relocated to Helgoland in the North Sea, where the platform has been converted for salt-water operations. The platform has been lowered twelve metres into the sea near the shore for the long-term collection of data on the habitats of marine organisms. The platform is connected to an onshore station via an underwater cable containing a power supply line and a fibre-optic connection. A trigger routine is programmed to synchronise the two cameras and the flash unit every thirty minutes. The onboard computer uploads the stereoscopic images onto the internet. The spatial distribution of the organisms is later measured and counted in the images. This prototype has been incorporated in the large-scale European project COSYNA (Coastal Observing System for Northern and Arctic Seas) since 2009. COSYNA is a comprehensive observation system for the surveying, forecasting, and scientific analysis of the current status and development of the coastal waters of the North Sea and Arctic Ocean (see COSYNA 2013b).

RemOs1 is a modular platform that can be equipped with various types of sensors.[Fig. 1] Currently, its main casing contains an optical stereo unit, consisting of two consumer-grade cameras (Canon 1100D), a four-port serial network converter, an onboard computer, a USB server, a cooling ventilator, a temperature sensor, and a leakage sensor. Figure 2 includes a view of the flash unit's casing and a steerable webcam used for monitoring the surrounding conditions. [Fig. 2]

The uncertain status of images in digital research processes prompted me temporarily to put aside the visual aspects of my study. Temporality, which had emerged from my videogram research as a productive aesthetic quality, encouraged me to rely entirely on the acoustic signal as a time-based medium. In March 2012, our team equipped *RemOs1* with various audio sensors.[7] Similar to listening to the internal sounds of an animal or human body using a stethoscope, we first identified neuralgic points where the electronic activity of the devices produced electromagnetic emissions that could be rendered audible via corresponding converters. Specially fitted "bypasses," located in the device's cabling, were used to record power consumption. The electromagnetic oscillation of the various power supply lines and processes made the idle mode perceptible to the senses as finely structured noise, from which the synchronisation and triggering process of the stereometric cameras, and the subsequent uploading of the images onto the internet via the onboard computer, differ significantly.[Fig. 3 & 4] A piezoelectric contact microphone fitted to the webcam converts camera and casing vibrations at sea into the acoustic range. The six audio signals are recorded by an autonomous mini-computer, a so-called Gumstix, via sound cards, and they are downloaded as audio files

7 Team members included Valentina Vuksic, project associate, computer artist, and information scientist, and Peter Meyer, an electronics technician.

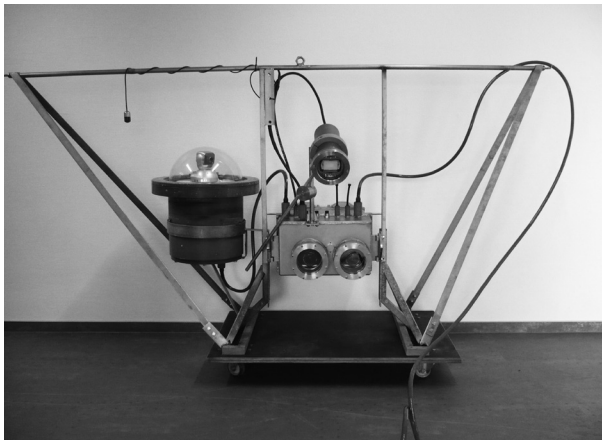

Fig. 1

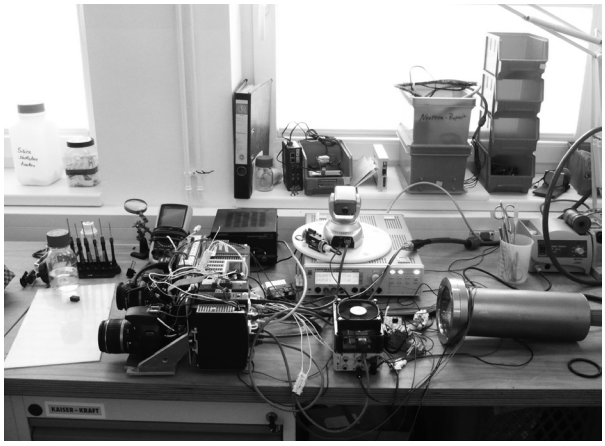

Fig. 2

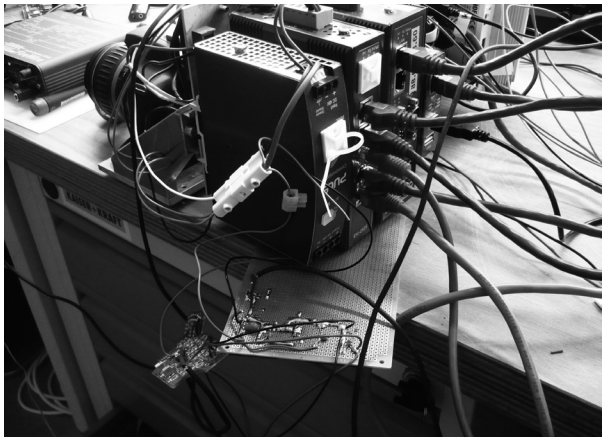

Fig. 3

Fig. 4

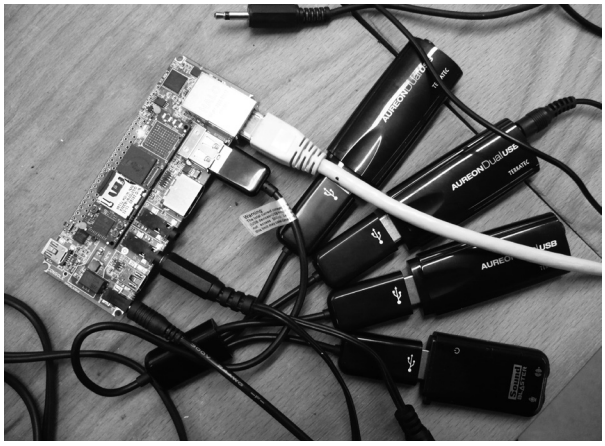

Fig. 5

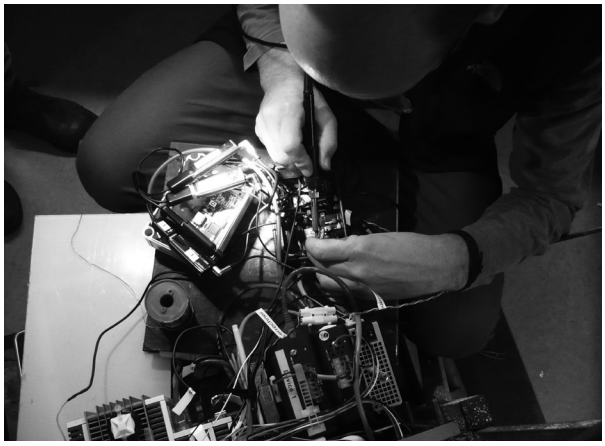

Fig. 6

Figure 1. A view of the main casing of *RemOs1*, including a stereo camera and a computer (lower centre), flash unit (upper centre), webcam casing (centre left). Top left, a hydrophone and a power supply and data cable. © Hannes Rickli.

Figure 2. The *RemOs1* equipment, as seen at the diving centre workshop of the Biological Institute Helgoland. © Hannes Rickli.

Figure 3. Power consumption sensor and pre-amplifier. © Hannes Rickli.

Figure 4. Electromagnetic sensor camera. © Hannes Rickli.

Figure 5. *Gumstix* and sound cards. © Hannes Rickli.

Figure 6. Installing *Gumstix* in *RemOs1* casing; electromagnetic sensor of the onboard computer (front left, cable tie installation). © Hannes Rickli.

via an internet connection.[Fig. 5] Before installing the Gumstix in the main casing,[Fig. 6] *RemOs1* was made waterproof and the gasket tested in the diving centre's test pool. Various improvements to the gaskets were necessary.

Originally, the auditive translation of the electromagnetic and electrical activities of the measuring and data transmission devices was intended solely as a vehicle for rendering perceptible the processes concealed inside the black boxes. It was envisaged that the Gumstix would transmit live data to an exhibition scheduled to take place in Berlin in January 2013. However, it soon emerged that the artistic intervention would have even more far-reaching consequences. Intervening in the central electrical and digital processes underway at the underwater station made the art project a participant observer and thus dependent on the momentary states of the *RemOs1* system and its research. In June 2012, *RemOs1* was relocated to Spitsbergen and lowered into the sea near Ny-Ålesund, a research village on the Kongsfjorden on the west coast.[8] Problems affecting the downloading of audio signals during the test phases in Helgoland and Spitsbergen necessitated readjustments to the Gumstix programme structure. In September 2012, with preparations underway for the system's first winter operation under the arctic ice, a third version, equipped with additional emergency provisions, was installed. Just as serious as the periodically fragile data transmission, which affected not only the audio signals but also the scientific stereometric images and leakage sensors of the casing, was the uncertainty about underwater power supply. During a parallel experiment on Helgoland, the plugs connecting the 1,000-volt submarine cable and the breakout box, which converts the power supply to the 48 volts needed for the *RemOs1*, had malfunctioned on several occasions due to water penetration or technical faults. On 15 September 2012, when the observation system was lowered into the sea off the research station's jetty, live streaming provided by two above-water webcams was also available. Fitted to a ferry-box container[9] situated immediately on the shore side of the jetty, the cameras provide three views: of the vanishing line from the jetty to the fjord; in a north-easterly direction, of the point at which *RemOs1* was lowered into the sea; and, at a right angle to the second frame, of the buildings of the Koldewey research station. Although the cameras are not directly involved in the research (they have been installed to protect the station against polar bears), the location of the image and data-generating processes struck me as valuable from an artistic perspective and I therefore decided to include them in the recordings.

The large volume of data meant that the direct and simultaneous transmission of the audio files, stereometric images, and video streams created a time-critical scenario, which neither my staff nor I were prepared for.[10] To exhibit material at the planned exhibition, I decided for safety reasons to forgo

8 On the underwater node and ferry box in Ny-Ålesund (Spitsbergen), see COSYNA (2013a).

9 A ferry-box is an automated laboratory for permanently monitoring seawater properties such as temperature, salinity, turbidity, chlorophyll, etc. Such devices are used worldwide on ferries to receive continuous and consistent measurement series.

10 A few days later, I discovered two further webcams, which capture the jetty and the research station in the same directions but from a greater distance and place the cameras in the geographical context.

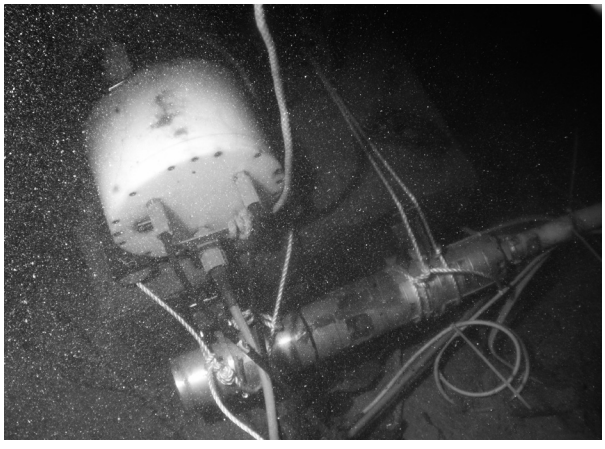

Fig. 7

Fig. 8

installing a streaming server providing live images and sounds; I chose instead to record all accidental images as long as the system proved functional. During the first few weeks, this was done manually while Valentina Vuksic, our information scientist, developed download routines capable of storing approximately thirty gigabytes per day. In this phase of the project, my team and I were confronted with the dynamics of the installed data processes in the shape of a flood of data that permitted no more than temporary storage and classification and that monopolised, in a precarious manner, all available resources for a longer time. The instruments and media, and their incessant output of products, determined our activities at will. What appeared in the art project as the experience of helplessness was actually one of the phenomena that I was seeking to explore in biology laboratories within the "Computer Signals" research project: how does the internal activity of the computer as a medium affect the dynamics of research practice and its resources? How does such activity shape one's proximity and distance to one's research subject?

Two and a half months after the deployment of RemOs1, our decision to record rather than live-stream the audio data from the six signals was proven correct. Water penetration, which the leakage sensors had failed to report, made the flash unit's steel casing rust through within a few days in late October 2012, causing a short circuit that brought down the entire system. Data transmission ceased. In February 2013, divers were able to salvage and repair the device. In a series of dives, undertaken over several days at an outdoor temperature of minus 20º C, the plugs and connectors were replaced as far as the breakout box. [Fig. 7 & 8]

Storing and automating audio and video data and simultaneously planning the Berlin exhibition did not allow enough time for evaluating the material beyond cursory inspection. It was not until the exhibition that the gathered material could be observed from different angles.[11] For this purpose, we experimented with various forms of time. Above-water and submarine images were synchronised: first, as a fast-motion sequence of the first thirty days after RemOs1 was brought into operation (see Archive, a video installation; loop duration: thirty hours); second, as a sample daily routine (8 October 2012), which was screened in real-time together with the audio signals and a log file

11 Schering Foundation, Berlin, 24 January to 23 February 2013, see Schering Stiftung (2013).

Figure 7. A view of the breakout box, the underwater nodes, the 480 V to 48 V submarine converter cable, and the *RemOs1* power supply line and data cable (left plug on breakout box); *foreground below*, the seawater pump of the ferry-box system. © Philipp Fischer.

Figure 8. A view of the *RemOs1* showing a stereometric test image and the webcam casing; Marine Laboratory workshop, Koldewey Station. © Philipp Fischer.

Fig. 9

Fig. 10

Figure 9. A view of the exhibition at the Schering Foundation, Berlin; rear, Sample, an installation; left, part of the Archive installation; front, 19" rack including a PC and sound card; steel structure for mounting loudspeaker and projectors (reconstruction of the outline of the main casing of RemOs1), 380 x 570 x 484 cm. © Roman Keller.

Figure 10. Video images taken inside fish facilities used for experiments on the social behaviour of the African cichlid; seen here is female mate choice. © Hans Hofmann.

of stereometric image-processing routines shown on an LED display (Sample, installation). In a third installation, the stereometric images were streamed live in the exhibition space but without any audio signals (Live, installation). Each time-format highlighted different aspects, thereby turning the exhibition into a means of analysing the obtained data. [Fig. 9]

The precarious power supply in the extreme environmental conditions found in the Arctic Ocean affects my artistic practice in no uncertain terms. It is impossible to neglect electricity as crucial to the technological research done at Kongsfjorden Long Term Fjord Observatory. The sheer banality of this point suggests that as we tend to take electricity for granted, we usually remain unaware of its significance as a fundamental condition of present-day empirical research. This applies not only to digitised research but also to the use of images in other social contexts, including my own. At this stage of my research, I am unable to determine whether electricity will become a major theme in my work on the scientific and artistic production of images.

Perhaps a digression on the beginnings of the theory of electricity in early Romanticism will lend impetus to such work. In "Die Physik als Kunst," a lecture delivered in 1806, the physicist and natural philosopher Johann Wilhelm Ritter (1776–1810) outlined physics as an art. By physics, Ritter meant mostly electrical phenomena, which he believed had the potential to discover new connections between nature and man, matter and spirit, and to shape their representation (see Specht 2010). The experiences generated at the underwater observatory off Spitsbergen suggest that electricity has the power to mould things into shape. It enables long-term digital studies in a hitherto inaccessible and ecologically sensitive geographical region while helping to configure research objectives by concentrating time and financial resources. Examples include the involvement of an information scientist in Philipp Fischer's research group, or the fact that the high-voltage submarine cable, measuring 120 metres, and its installation between the shore and the underwater node to which the measuring devices are connected, has been the most expensive investment during this research project.

Astatotilapia burtoni (African Cichlid) and Black Box Cooling

In April 2013, I visited the biologist Hans Hofmann in the United States for the third time, after two previous visits in 2000 and 2008. [Fig. 10] Over a period of twenty years, I have seen his research develop through various stages. Since 1998, Hofmann's laboratory has been studying the neural and molecular mechanisms that underlie social behaviour and its evolution. Based at the University of Texas at Austin (UT), one of the largest and most influential state universities in the United States, Hofmann's research in this area focuses on the *Astatotilapia burtoni*, the African cichlid fish. The fish facilities where the experiments with the cichlids are conducted and recorded on webcams are located in the basement of the J. T. Patterson Laboratories Building on the UT Campus. On its third floor, in the Hofmann Lab's physiology and

molecular biology laboratory, tissue samples, including brain sections, are prepared for DNA sequencing.[12]

Below, I discuss the infrastructure situated between the specific events occurring in the aquarium and the invisible processes unfolding in a series of black boxes. This marks an attempt to substantiate the purported reshaping of the material by technology and to explore the computer-modulated relations between digital data operations and fish behaviour.

Just as in the early days of genome research when samples were dispatched for analysis to commercial firms, a similar development is now under way in the case of video facilities, albeit on a different technical level. Next-generation sequencing technology provides DNA and RNA sequencing devices costing around $1 million, but devices are becoming increasingly less expensive. Together with bioinformatics scientists, Hans Hofmann founded the Center for Computational Biology and Bioinformatics (CCBB).[13] The CCBB is affiliated with the Genome Sequencing and Analysis Facility (GSAF), which operates the Illumina HiSeq 2000, a state-of-the-art scanner. This in-house solution enables the flexible handling of analysis technology, that is, the simultaneous high-resolution sequencing of several small-size samples. Such sequencing permits the genomic exploration of cichlid behaviour, without incurring the considerable loss of time between sample collection and analysis due to dispatch by post. Nevertheless, I am struck by the amount of time required, since scanner analysis using the Illumina HiSeq 2000 can take up to seven days. To cope with increasing demands for analysis, the GSAF recently decided to purchase a second scanner.

In connection with my art project, I made electromagnetic recordings on the scanner's casing—that is, on its exterior.[Fig. 11] On these recordings, the operating rhythm of the lasers is audible, as is sensing and gauge changing. Unlike the *RemOs1* underwater system, which relies on consumer-grade devices to ensure greater agility in the field and employs open-source software, the electromagnetic source cannot be recorded directly inside the high-tech HiSeq scanner.

Besides several high performance computing (HPC) clusters, employed for data analysis, the CCBB maintains its own storage servers, whose current capacity is 78 terabytes (excluding tape backups), for the intermediate storage of research data [Fig. 12]. Special facilities are used to store sensitive data.

I recorded the effects of the electromagnetic fields synchronically with the vibrations of the ventilation systems and the chilled water lines. Devices and facilities are cooled using electrically powered air conditioning systems in combination with chilled water, which is distributed through over six miles (9.7 km) of chilled water lines at a temperature of 39º F (3.9º C). The recommended server room temperature is 57.4º F (14.1º C). In Central Texas, where outdoor temperatures rise to approximately 35º C for one third of the year, energy consumption for cooling building and computer facilities is considerable (ca. 1.15 million kilowatt hours).

12 For details on the research and experiments conducted at the Hofmann Lab, see Rickli (2011, 200–33 [see 51 for an English supplement]). See also Hofmann Lab (2013).

13 See Center for Computational Biology and Bioinformatics (2013).

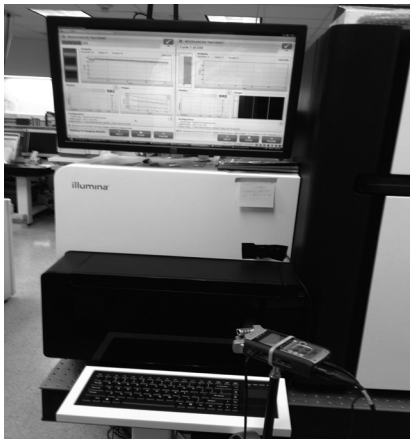

Fig. 11

Fig. 12

Fig. 13

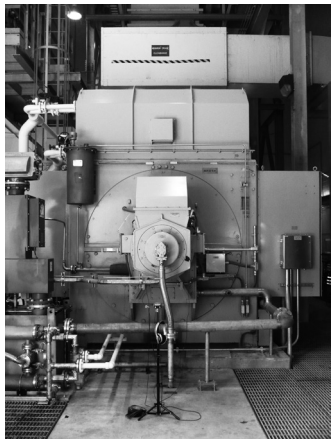

Fig. 14

The electricity needed to produce chilled water comes from an on-campus, natural-gas-fired combined heating and power facility that operates independently of the public electricity network. The building seen between the two chimneys is the Hal C. Weaver Power Plant, behind which towers the Darrell K Royal–Texas Memorial Stadium, where the Texas Longhorns college football team (founded in 1893) plays its six home games before a crowd of over one hundred thousand spectators. Immediately before the stadium are the cooling towers of Chilling Station 6. The photograph in figure 13 is taken from the roof of the J. T. Patterson Laboratories Building facing south-east. [Fig. 13]

Figure 14 shows the synchronic recording of the electromagnetic fields on the generator exciter housing of the thirty-two-megawatt gas-turbine generator and the vibrations on the lube-oil line. [Fig. 14]

The photograph in figure 15 shows one of the four chilling stations designed to provide chilled water to the main campus. In an indoor facility measuring approximately two thousand square metres, water is pumped up to the roof, where ventilators extract the warmth, causing the water to precipitate and gather below. [Fig. 15]

Figure 11. A view of the DNA/RNA Illumina HiSeq 2000, Genome Sequencing & Analysis Facility (GSAF). Electromagnetic audio-recordings pick-up mounted on the white front cover with black duct tape. © Hannes Rickli.

Figure 12. Electromagnetic audio recordings made on the CCBB storage server. © Hannes Rickli.

Figure 13. Hal C. Weaver Power Plant, Chilling Station Cs 6. © Hannes Rickli.

Figure 14. Hal C. Weaver Power Plant, generator section of a 32-megawatt gas turbine, electromagnetic and piezoelectric audio recordings. © Hannes Rickli.

Fig. 15

Fig. 16

Fig. 17

Located at UT's Pickle Research Campus just outside Austin, Stampede is one of the largest computing systems in the world.[14] [Fig. 16] This system is used at the Hofmann Lab and the CCBB to process the reads, which are divided into small sections by HiSeq analysis and marked at either end, into longer "contigs" and complete gene sequences. Despite its enormous computational capacity, the current version of Stampede is suited only partly to Hofmann Lab and CCBB requirements, since such computers are designed to simultaneously perform an array of parallel operations. Large computing systems have a life span of four to five years. The Hofmann Lab and CCBB biologists are also invited to help develop the next generation of computers, since the scientists' growing digital requirements demand serial operationality to recalculate the same data on various levels.

Stampede—like its predecessor Lonestar 4, which is still operational, and the data storage systems Ranch and Corral—requires permanent cooling. A chilling station located on the Pickle Research Campus is used to generate chilled water. [Fig. 17] Upgrading supercomputers is meanwhile limited neither by processor speed nor by data storage capacity but by securing the funds for chilling stations. For this reason, trials are under way at TACC to submerge the hard drives in slowly circulating mineral oil during operation. This

14 See Texas Advanced Computing Center (2013).

Figure 15. Chilling Station 5, Indoor precipitation facility. © Hannes Rickli.

Figure 16. Stampede, Texas Advanced Computing Centre (TACC). Synchronic electromagnetic and piezoelectric audio recordings of servers and switches. © Franz Krähenbühl.

Figure 17. A view of the new flat-roofed building designed to house *Stampede* (centre right); the photograph was taken from the roof of the cooling tower and also shows the ventilator casing (left). © Hannes Rickli.

method still seems far from feasible, however, since submersion causes hitherto unresolved problems with the plugs.

Let me conclude my series of snapshots here by way of a summary and brief outlook. I have encountered electricity in highly diverse ways, on the one hand at Spitsbergen (which I have never visited and know merely from books about Amundsen's polar expeditions and from the webcams operating at Ny-Ålesund jetty), and on the other in Texas. Nevertheless, there are certain parallels between the manifestations of electricity at these two locations. Electricity could be seen as a plastic means of design, which shapes and deflects but also limits what we are able to know. The question arises: should the economic, ecological, and political discourses on the energy issue perhaps be extended to an epistemic discourse that accounts for, and illuminates, the horizons of technology-based research? No matter how one might answer this question, I shall happily pick up the thread of electricity next summer, when I accompany an expedition to be undertaken by Philipp Fischer and his research team. Or I will pick up that thread when I create an audio panorama out of a twenty-four-hour synchronic recording in Texas: in one direction, the panorama will consist of the simultaneous electromagnetic and piezoelectric emissions of various devices (HiSeq, CCBB server, the power plant's gas turbine, and Stampede) related to the African cichlid aquaria standing in the basement of the Paterson Building; in another direction, the recording will feature the oil and gas fields in West Texas which could be used to supply fuel to the Hal C. Weaver Power Plant gas turbine. The State of Texas transferred the fields to UT Austin in the years 1876 and 1883. The revenue from oil and gas production, together with grazing leases concluded with ranchers, were paid into the so-called "Permanent University Fund," which covers a significant part of the endowment of the University of Texas. In addition, the university receives annual royalty payments from companies exploiting the oil and gas fields belonging to the UT System.[15] Fracking, a technique for exploiting oil and gas fields that is heavily criticised in Europe, has prevailed almost unquestioned in Texas, making the Lone Star State the third-largest oil and gas producer in the world. In future, I would like to link the audiospheres of the fracking industry both to some of the research actors described here and to art.

Various levels pervade one another in my work: the experiments being done by biologists; the reflections of science studies scholars such as Hans-Jörg Rheinberger, Bruno Latour, and Christoph Hoffmann on how research practices are couched in technological terms (Hoffmann is also studying the work done at Philipp Fischer's and Hans Hofmann's partner laboratories; his work has opened up various theoretical approaches that enable me to classify the objects and processes observed at the laboratories); and last but not least, my own attempts, made in artistic experiments, to open up small cracks in black boxes so as to bring aspects of their invisible operations and their modes of action closer to perception.

15 See University of Texas System (2013).

REFERENCES

Center for Computational Biology and Bioinformatics. 2013. Homepage of Center for Computational Biology and Bioinformatics, the University of Texas at Austin. Accessed 16 July 2013. http://ccbb.biosci.utexas.edu.

COSYNA. 2013a. "AWIPEV Underwater Long Term Fjord Observatory." Helmholtz-Zentrum Geesthacht: Zentrum für Material- und Küstenforschung. Accessed 16 July. http://www.hzg.de/institute/coastal_research/cosyna/033338/index_0033338.html.

———. 2013b. "COSYNA—Coastal Observing System for Northern and Arctic Seas." Helmholtz-Zentrum Geesthacht: Zentrum für Material- und Küstenforschung. Accessed 16 July. www.cosyna.de.

Hofmann Lab. 2013. "About Our Lab." The Hofmann Lab: Mechanisms and Evolution of Social Design Making. Accessed 16 July. http://cichlid.biosci.utexas.edu.

Institut für Gegenwartskunst. 2009. "Tagung 'Latente Bilder: Erzählformen des Gebrauchsfilms.'" Institut für Gegenwartskunst. Accessed 16 July 2013. http://www.ifcar.ch/index.php?id=22&sub=51&lang=d.

———. 2013a. "Computersignale: Kunst und Biologie im Zeitalter ihres digitalen Experimentierens." Accessed 16 July. http://www.ifcar.ch/index.php?id=211.

———. 2013b. "Überschuss: Videogramme des Experimentierens." Institut für Gegenwartskunst. Accessed 16 July. http://www.ifcar.ch/index.php?id=187.

Jacob, François. 1998. *Of Flies, Mice, and Men*. Translated by Giselle Weiss. Cambridge, MA: Harvard University Press. First published 1997 as *La souris, la mouche et l'homme* (Paris: Éditions Odile Jacob).

Latour, Bruno. 1993. "Le 'pédofil' de Boa Vista—montage photo-philosophique." In *La clef de Berlin et autres leçons d'un amateur de sciences*, 171–225. Paris: La Découverte.

Rheinberger, Hans-Jörg. 1992. *Experiment, Differenz, Schrift: Zur Geschichte epistemischer Dinge*. Marburg an der Lahn: Basilisken-Presse.

Rickli, Hannes, ed. 2011. *Videogramme: die Bildwelten biologischer Experimentalsysteme als Kunst- und Theorieobjekt / Videograms: The Pictorial Worlds of Biological Experimentation*. Zürich: Scheidegger & Spiess.

Schering Stiftung. 2013. "Hannes Rickli: *Fischen Lauschen*." Schering Stiftung. Accessed 16 July 2013. http://www.scheringstiftung.de/de/projektraum/rueckschau/2684-hannes-rickli-fischen-lauschen.html. Published in conjunction with the exhibition of the same name, shown at Schering Foundation, Berlin.

Specht, Benjamin. 2010. *Physik als Kunst: Die Poetisierung der Elektrizität um 1800*. Berlin: De Gruyter.

Texas Advanced Computing Center. 2013. "Stampede: Dell PowerEdge C8220 Cluster with Intel Xeon Phi Coprocessors." Texas Advanced Computing Center. Accessed 16 July. http://www.tacc.utexas.edu/resources/hpc/stampede.

University of Texas System. 2013. Homepage of the University of Texas System. Accessed 16 July. http://www.utsystem.edu.

Material Experiments

"Phenomeno-Technology" in the Art of the New Materialists

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Crumbly dirt, finely sifted pastel-coloured powder, water that has been transformed into steam by ultrasound vibrations, trickles of oil, and chlorine bleach on canvas—numerous young contemporary artists have begun to concentrate again on material qualities and aggregate states and on a corresponding minimalised formal idiom. The materials used are often left in a raw state. Marked by traces of use or slight artistic interventions, in no way do they appear to be tamed; rather, they disclose their recalcitrance and resistance, the special quality of their texture and make, their bulkiness and mutability, their limitedness and their potential for transformation. In the international art scene, the first exhibitions to pursue this phenomenon speak of a "new appreciation for materials" and their creative powers (Bono 2010, 17), of "co-participation" with and allowing one to be guided by the material (see Jones 2009), as well as an "approach to material experience" (Fisher 2009)[1] that confronts language "as a dominant mode of thinking" (Dander and Lorz 2012, 20).

With a few exceptions, such as works by Nina Canell, these primarily sculptural, installative works of art, while testifying to a distinct new materialism, do not recall scientific experiments. Unlike many of the works encountered in the 1990s, these lack, for the most part, the specific laboratory aesthetic, the Petri dishes, the test tubes, and the observation and recording devices. Thus, in no way does a reference to Hans-Jörg Rheinberger's concept of the experimental system impose itself upon us, and yet this concept illuminates many of the installations created by the New Materialists—which is how I would like to designate them hereafter, without proclaiming the existence of a definite group having a similar canon of form or material.[2] For the direct comparison

1 "They also share an approach to material experience as a way of thinking and communicating that actively avoids or downplays language, often pointing to its inadequacy and essentially abstract nature" (Fisher 2009).

2 Besides Karla Black and Nina Canell, the New Materialists might also include, among others, Andrea Bircken, Sergej Jensen, and Gedi Sibony.

of these artworks with the peculiarities of these "basic units of the scientific tracing-game" (Rheinberger 1997, 224) reveals fundamental parallels that help us to grasp their structural composition as well as track down their forms of representation and epistemic and experiential values.

The term "New Materialists" makes reference to new approaches, which are subsumed under the term "New Materialism," in a wide variety of disciplines across the humanities and social sciences.[3] These initiatives oppose the purely constructivist and linguistic approaches of the past, which emphasised the language-based construction of reality and the momentum of symbols and discourses. Instead, they re-elevate the significance of the world of matter and materials, of things, objects, and bodies for cultural practices, and they conceive matter as recalcitrant and vibrant,[4] possessing agency and driving forces. In this respect, they exhibit surprisingly close parallels not only to those contemporary artistic stances for which the term "New Materialists" is proposed here for the first time but also to Rheinberger's description of scientific experimental practice.[5]

CAUSING PHENOMENA TO TALK

The Scottish artist Karla Black is one of the most prominent representatives of the New Materialists. Her materials include cellophane, hand cream, lip-gloss, eye shadow, fingernail polish, toothpaste, and makeup, as well as conventional artistic materials such as pigments, gypsum powder, lime, and large sheets of paper, which she occasionally hauls into exhibition spaces by the ton. With a great deal of physical effort on the part of the artist, sculptures emerge that alternate between form and formlessness.[6] In this way, the haptic and substantial qualities of the materials used, as well as the various traces of colour and textural relationships, issue forth from apparently fragile layers and accumulations of loose particles, powdery surfaces of colour, creased plastic wreaths, or paper constructs coated in part with paint or cosmetic substances in a "'pre-object' type state," in the artist's words (Black 2010, 177). In the work *Pleaser* (2009), [Fig. 1] of which there are different variations, the materials are even applied between or on transparent foils—much like a specimen on an object slide—and in this way impart a manifest quality to the pastosity or fluidity, richness or lean porosity of the material, as well as to the traces of handling and colour nuances.

"A lot of what I do is about trying to find a way to... bring raw material and colour just up—like into the air to eye level," Black explained in an interview

3 See, among others, Coole and Frost (2010); Dolphijn and Tuin (2012). Refer also to the 2012–13 lecture series "Power of Material / Politics of Materiality" at the cx centre for interdisciplinary studies at the Academy of Fine Arts Munich, on which see cx centre for interdisciplinary studies (2012).

4 See Bennett (2010).

5 As far as I know, Rheinberger's possible contribution to the approaches of New Materialism has not yet been acknowledged in detail. This situation could change as a result of the series of lectures "Materialism and New Materialism across the Disciplines" planned for 2013/14 in the Humanities Research Center at Rice University, Houston. At the time of writing, Rheinberger was due to contribute a lecture in April 2013 as part of the series (see Humanities Research Center 2013).

6 On "formlessness" see, among others, Bois and Krauss (1997).

Fig. 1

in 2011 (Arts Council Collection 2011, 3:18), speaking of her attempts to lend a specific visibility to the materials and colours in her sculptural arrangements, to reveal them to the senses as phenomena.[Fig. 1] By doing so, she hopes to bring out the physical resonance of materiality and colour, for their ability to be palpably experienced by the viewer, which she intends will contribute to an understanding of the world. "I first and foremost want to prioritize material experience over language as a way of learning and understanding the world," says Black (2010, 178). And elsewhere she explains: "The things themselves are actual physical explorations into thinking, feeling, communicating and relating. They are parts of an ongoing learning, or search for understanding, through a material experience that has been prioritised over language" (Black 2007). Time and again Black returns to individual concepts for works whose openness and indefiniteness enable her to alter and test them in new, possibly improved versions. In this respect, the individual work is subordinate in Black's oeuvre. Instead, the artist seems to set up a series of tests and to work with conglomerates of related specimens.

This method of working appears to exhibit initial parallels to Rheinberger's description of the experimental system. Making reference to the epistemologist Ludwik Fleck, Rheinberger explains that it is not the individual experiment that is the path to scientific insight. Rather, to achieve useful results, a scientist requires a complete experimental setup, an entire system of experiments and controls—that is, an experimental system. The Experimental system, not the individual experiment, is "the smallest integral working [unit] of research"

Figure 1. Karla Black, *Pleaser*, 2009, cellophane, paint, Sellotape, thread, 200 × 250 × 70 cm. (Photograph by Fred Dott. Courtesy Galerie Gisela Capitain, Cologne.)

(Rheinberger 1997, 28). Furthermore, it must be sufficiently open in order to remain a productive research system, to "produce unprecedented signals and allow the infiltration of new technologies, instruments, and model substances" (Rheinberger 1992, 28, translated by Rebecca Van Dyck [R. V. D]). If the result is known in advance, the experimental system degenerates, becoming merely the production of standards or replicas. Experimental systems "must be organized in such a way that the production of differences becomes the reproductive driving force of the whole machinery" (Rheinberger 1997, 224).

Both the work in preparatory test series in the studio or in series in the exhibition space and a general openness in terms of the possibility of varying artistic methods and media are of course essential for an art that consistently and innovatively works on ways of dealing with specific questions and problems. Artistic strategies and repertoires of form and material have to allow a certain degree of "*différance*"[7] to be suitable as working means that engender something new instead of exhausting themselves in rigid repetitions.

However, beyond the more general characteristics of contemporary art, what connects works by Black—as well as several other works of art by the New Materialists—with the experimental scientific system is to a great extent the manner of "representation." Rheinberger (1997, 103) distinguishes between three types of representation that constantly generate themselves, shift, and overlie one another in the sciences and that he labels symbol, icon, or index according to Charles Sanders Pierce's semiotic system. In the representation "of" something "we are... accustomed to speaking of analogies, of hypothetical, more or less arbitrary constructs" (symbols), while representation "as" something "takes on a double meaning: that of vicarship and that of embodiment" (ibid.). This results in models or a simulation (icons). Finally, representing something can also mean to realise that thing. In this case, the representation consists of "traces realised experimentally" (Rheinberger 2006, 128, translated by R. V. D.; experimentell realisierte[n] Spuren)[8] (indices). It is the second and third forms of representation that have priority in the experimental system. According to Rheinberger (1997, 225), "Experimental scientists, in their daily bench work, deal with material units, with traces to which they convey the significance of being the 'reals' of their particular practice." The experimental system leads to an "epigraphy of matter" (Bachelard 1988, 168, translated by R. V. D) and "getting the investigated phenomena to talk" (Rheinberger 2007, 86). It is not theories or arguments that are assigned primacy or control, nor hypothetical constructions of the research object. Instead, this research object is "revealed within a space of material representation and brought to articulation" (Rheinberger 2012,

7 Rheinberger borrows the term "*différance*" from Jacques Derrida and cites it as an essential feature of a research system: "An experimental system that is organized in a way such that the production of differences becomes the orienting principle of its own reproduction is governed by and at the same time creates that kind of subversive movement Derrida has called *différance*" Rheinberger (1997, 81).

8 In this case, I would like to quote the phrase in a new English translation, because in the later German-language edition Rheinberger defines his terms more precisely than in the English-language edition (Rheinberger 1997)

95). Models can thereby act as important aids. In science they are "to a certain extent and in some respects, standardized, reduced, purified, isolated, contracted, and monofunctionalized entities" (Rheinberger 1997, 109) that are particularly well suited for experimental practice. They substitute for substances, reactions, systems, or organisms that are less available, transportable, or manipulable.

Karla Black's works also force an indexical and iconic form of representation and attempt to overwrite or play down their symbolic qualities. "My work doesn't point outside of itself to metaphor or to the symbolic, to language, to meaning. Often people will ask, 'What is the meaning of this sculpture?' I can't understand that question," explained the artist on the occasion of her exhibition at the 54th Venice Biennale (Black 2011, 1:28). To counter the ascription of meaning and have the materials manifest as materials, Black primarily adheres to two corresponding strategies that are quite common in contemporary art. One consists in "circumventing objectness altogether" and thus "suspending its usefulness for a certain purpose, i.e., leave the world of human categories, intentions, and interpretations," as Karl Schawelka (2002, 19, translated by R. V. D) so aptly formulated it in his essay "More Matter with Less Art'? Zur Wahrnehmung von Material." The other consists in using materials that are not necessarily considered to be common or typical in an exhibition context. These unusual substances irritate and sensitise the viewer's eye. In this way, they act not only as independent material phenomena but also as "tracers" for tracking purposes, enhancing the display of the marks of all the materials used.[9]

The symbolic quality in the sculptures by Black cannot, however, be eradicated completely. The artist seems to be at odds with their autonomy, while she deliberately emphasises the iconic quality of her sculptures. Black explains that she is not concerned with symbolically representing a landscape, set pieces, or phenomena such as table mountains, boulders, strata, clouds, surf, barren land, clumps of snow, pollen, foam, or rain, of which some of her works are reminiscent, but with making a sculpture ostensibly recognisable as a natural phenomenon by making it look "as if it just arrived in the world of its own accord—just naturally came into existence" (Black 2010, 176). The artist does not strive for the representation "of" nature or material reality, "but rather a calling up of the sensation of it" (ibid.). In fact, her sculptures can rather be understood as iconic representations, as "vicarship and… embodiment" (Rheinberger 1997, 103). They seem to act as model substances and model systems, as "material generalities" (ibid., 109) of the material world—the "natural" but also the "artificial." For the artist ultimately does not make a fundamental distinction between materials originating from nature, from the art supply store, or from the art industry. "I don't differentiate between those things. That stuff is just all what the material world is made up of," to quote Black (2011, 1:17).

9 Referring to scientific experimental systems, Rheinberger (1997, 110–11) writes: "If epistemic things do not intrinsically display recordable marks that transform them into machines that become themselves productive, tracers are introduced into them."

Fig. 2

Fig. 3

Figure 2. Nina Canell, *Perpetuum Mobile (40 kg)*, 2009–11, water, bucket, ultrasound, cement. (Photograph by Robin Watkins. Courtesy the artist, Konrad Fischer Galerie, Mother's Tankstation, and Galerie Barbara Wien.)

Figure 3. Nina Canell, *Another Ode to Outer Ends*, 2011, bucket, water, cement, glass, ultrasound, wood. (Photograph by Robin Watkins. Courtesy the artist, Konrad Fischer Galerie, Mother's Tankstation, and Galerie Wien Lukatsch.)

MATERIAL AS AGENT

Numerous other works of art by the New Materialists are informed by an indexical form of representation alongside an iconic one, while the symbolic retreats into the background or is deliberately subverted. One could even say that this is one of their main features. Works by the Swedish artist Nina Canell, for example, which at first glance do not seem to have much in common with works by Karla Black, can also be described as experimental artistic systems that reveal (im)material phenomena to the senses. Canell's gaunt assemblages, composed of cables, neon tubes, used objects, technical devices, and matter in various aggregate states, unfold to become "assiduous investigations of the sculptural possibilities and properties of such recalcitrant materials as sound, light, water, steam, and electromagnetism" (Mac Giolla Léith 2010, 36). In doing so, her artistic test arrangements frequently aim at making visible the energy flows or transformation process of materials. In *Another Ode to Outer Ends* (2010), [Fig. 2] for instance, a sound generator causes water in a bowl to vibrate so that steam is produced. This precipitates onto loosely distributed cement dust on a floor plate, where it leaves traces of solidification and clumping, dissolution and settlement. In addition, this is not an isolated work but part of an entire "evaporation test series" that also includes *Perpetuum Mobile (2400kg)* (2009) and *Perpetuum Mobile (40 kg)* (2009–11, fig. 3), in which the ultrasound vibrations of a fog machine generate steam that in turn inscribes itself into cement sacks of different weights. Canell also interprets the disseminating acoustic waves or particles (radiance) as a manifestation of matter. She defines "radiance as a sculptural, relational component," making reference to the chemist and spiritualist Sir William Crookes (1832–1919), who besides solid, liquid, and gaseous denoted a fourth state of matter: radiant (Mac Giolla Léith 2010, 37). [Fig. 3]

In an extended sense, specific series or groups of works by Canell, such as the "evaporation series," are experimental systems according to Rheinberger, as they generate experimentally realised traces or substances. However, it would be trite if Canell's works exhausted themselves in the generation of steam or traces in cement. On the contrary, like Karla Black's, her works provide models (model substances and systems) "on the basis of which a process or a reaction can be studied" (Rheinberger 2006, 134, translated by R. V. D.; an denen ein Vorgang oder eine Reaktion studiert werden kann)."[10] They are substitutes for similar processes of this kind or for general processes of transformation between different material states and energies or between what is not perceptible and what can be experienced in terms of material—processes whose principles are brought to articulation here in several variations.[11]

In this context, material reveals itself to be an "agent," to use a term from Bruno Latour—an agent which, in addition to its own features and potentials

10 Also in this case, I would like to quote the phrase in a new English translation, because in the later German-language edition Rheinberger defines his terms more precisely than in the English-language edition (Rheinberger 1997).

11 Such processes might even include transformations between mental and natural processes. Cf. Roelstraete (2010, 71).

for transformation, demonstrates the transformation process itself in the experimental structure. Thus, in his essay "Do Scientific Objects Have a History? Pasteur and Whitehead in a Bath of Lactic Acid," the French sociologist and philosopher uses Louis Pasteur's 1858 laboratory experiments with lactic acid ferment to demonstrate that it is not simply "a creature defined by attributes" that is being discovered by someone, but rather "a body with multiple and partial members seeking to bring out in its laboratory, through a series of trials, a regular succession of actions" (Latour 1996, 84). Test arrangements or experimental systems challenge, so to speak, all their participating agents to "show achievements by means of trials" (Belliger and Krieger 2006, 37, translated by R. V. D). These become visible in how the agent influences other agents, how it changes, transforms, or engenders them. Unlike Latour, Rheinberger (1997, 225) does not speak of non-human "agents," but he does speak of the "resistance, resilience, recalcitrance" of the material with which scientists deal "in configuring and reconfiguring epistemic things." Rheinberger also acknowledges that material aspects and objects of investigation in an experimental system participate in the production of scientific knowledge, which is why constructions are only possible to a limited extent.

The potency and agency of material phenomena become particularly evident in Canell's experimental systems, in which actions really do occur and agents change, transform, or engender other agents. Acoustic waves transform water into steam, exercising an influence on a potted plant at a specific frequency (see Seyfarth 2011), and steam, in turn, transforms cement powder into a solid; electric and electromagnetic signals change into sound (see Roelstraete, 2010, 73); or a rotation changes into a vibration, a vibration into a sound, and a sound into light[12] (see Galerie Barbara Wien 2008). Yet, in Black's works as well, one can in no way proceed from a static and passive concept of material and matter. The Scottish artist generally leaves her material behind in a raw and very special intermediate state. She uses, for example, "paint that will never dry because it is mixed with petroleum jelly or plaster that will remain as powder and never be transformed into hard form" (Black 2010, 176). For Black, material also plays an active part in the artistic process of creation. This process is less about constraining the material's resistance or intractability than about interacting directly and physically with the various substances that codetermine the final result. Jonathan Griffin (2008, 169) even speaks of an "intimate and coercive conversation that Black conducts with her materials, which, if it didn't take place in guarded privacy, could be seen as performance."

EXPERIMENTAL CONDITIONS AND EPISTEMIC THINGS

But who counts among the agents in the experimental artistic systems of Black and Canell described above? Where do their experimental systems begin and end, and where are the boundaries drawn between their (technical)

12 For example in Black's 2008 *Anatomy of Dirt in Quiet Water*, for which see Galerie Barbara Wien (2008).

conditions and their epistemic objects? Rheinberger (1997, 28) calls epistemic things "material entities or processes… that constitute the objects of inquiry." In this context, the concept of the "object" comprises not only objects and substances but also reactions, structures, and functions as well. Epistemic things are initially in a vague, tentative, and undefined state. Their (re)definition and "focusing," or their articulation, require certain relevant conditions and technologies (instruments, recording devices, model organisms). Gaston Bachelard (1988, 18; translated by R. V. D) therefore referred to modern natural science as "phenomeno-technology," because it does not simply come upon or discover its objects of investigation but "intensifies… that which filters through from behind the phenomenon." Thus it must first create the conditions under which the phenomenon being investigated is brought into existence. According to Rheinberger (1997, 29), in contrast to epistemic things, these (technical) conditions "tend to be characteristically determined within the given standards of purity and precision"; they embed the epistemic things, restrict them; "It is through them that the objects of investigation become entrenched and articulate themselves in a wider field of epistemic practices and material cultures." However, neither of the two components of the experimental system is strictly separate and static. They closely interact, slide into and out of each other, and can even change roles.

Similarly, when considering the experimental artistic systems of Nina Canell and Karla Black, one cannot assume static boundaries between epistemic things and (technical) conditions. And yet it is apparent that the aforementioned interaction runs along different boundaries in the different artists' oeuvres. While Canell's installations impose the conditions for artistic phenomeno-technology largely on their own, in Black's sculptures they have been partially removed. Canell's assemblages are generated out of instruments, such as sound and current generators, cables, or receptacles; recording devices, such as amplifiers, antennas, neon tubes; or cement dust and model substances, such as water, electricity, or sound. They comprise the (technical) condition for the manifestation of the various aggregate material states and transformation processes and also substantially codetermine the works' aesthetics. Their crude, bricolage-like nature and fragility disclose not only the constructive character of artistic and scientific phenomeno-technology but also the artist's as well as the scientist's hesitant search-movements, which seek to lend visibility and sharpness to epistemic things by tentative tinkering.

In contrast, for Black, besides work-immanent aspects such as unusual materials employed as tracers, visible breaklines, or a hovering presence at eye level, the exhibition space and the visitor are subject to the "technical" conditions of her experimental artistic systems. But it is not that no meaning whatsoever is assigned to the space and the visitor in the above-mentioned works by Canell. Quite the contrary; however, the exhibition space, in particular, is far less bound to the consistence and function of most of her experimental systems than is the case for Karla Black. For Black, the architectural framework of a specific exhibition institution, for example, often serves as a central point of departure

Fig. 4

for choices of colour, material, and form for her space-consuming sculptures,[13] and it even seems to be the source of her phenomena. The works *Empty Now* and *Will Attach* (2012), [Fig. 4] for instance, respond to the classicist architecture of the Gallery of Modern Art in Glasgow, from which their qualities seem also to have been spawned. While the tiramisu-like layering, consisting of different shades of sawdust, of the former work, a powerful floor sculpture, takes up the graphic rigour and colour of the coffered barrel vault and the fluted columns, the latter work, made of lightly knotted cellophane, corresponds to the floral decor of the Corinthian capitals or the hearts of the ceiling coffers. As a sight prosthesis, the architecture in this way acts as a visual amplifier for the sculpture's play of colour, forms, and material qualities. On the other hand, it is in precisely this exhibition by Black that a change of roles takes place such as Rheinberger mentions for components of the scientific experimental system.

13 "The work is, to a certain extent, site specific in that I respond, albeit vaguely, to a gallery space or at least think about where the objects will end up before and during making them" (Black 2007).

Figure 4. Karla Black, Installation view, 2012, Gallery of Modern Art, Glasgow. (Photograph by Ruth Clark. Courtesy Galerie Gisela Capitain, Cologne.) The lower part of the installation is *Empty Now*, 2012, sawdust (pine, teak, oak, maple, yew), balsa wood, balsa foam, eyeshadow, 1.2 × 10 × 24 m. (Courtesy Galerie Gisela Capitain, Cologne.) The higher part of the installation is *Will Attach*, 2012, cellophane, Sellotape, paint, bronzing gel, shampoos, lipgloss, nailvarnish, dimensions variable. (Courtesy Galerie Gisela Capitain, Cologne.)

The architecture mutates from a (technical) condition into an epistemic thing, which seems to be catapulted by the artist's works into the sphere of the visible. Thus *Empty Now* points out the impressive dimensions and pure geometric proportions of the barrel-vaulted hall, brings to light the blocky constitution of the structure and the cool alignment, and reveals the earthy choice of colours and the massive materiality of entablature and ceiling. *Will Attach*, however, lets the character of the classicist decor emerge, which is floating, so to speak, over the constructive architectural elements and whose filigree lightness and organic repertoire of forms in the interplay of light and shadow thwart its stringency and coolness.

Beyond this, a particularly exposed role is assigned to viewers of Black's experimental systems. The artist wants them to first be a sounding box and instrument of analysis and be directly affected by the physical qualities of her sculptures. There are no amplifiers or antennas—which is the case for Canell's works—to act as mediators to record the impact of the material agents; rather, the viewers, through direct sensuous experience, themselves become the sole recording devices and the points of culmination of physical knowledge, which requires no further translations or verbalisation. Thus, in Black's experimental systems, the viewers count among the conditions of her epistemic objects in an especially direct way, even if they, in all their individualism, self-referential reaction, and subjective fickleness, in no way conform to the precision and purity required of technical conditions in experimental scientific systems. This in turn makes them potential epistemic objects, for specific modes of behaviour and personality structures could be revealed in their specific reaction to and relationship with the material world.[14] At least, the artist consciously puts out this possible interpretation. Black mentions that her works are based on the psychoanalytic theory put forward by Melanie Klein. Against the scientific achievements of this Austrian-British cofounder of and specialist in the area of object-relations theory, which analyses patients' behaviours less by way of language-based communication than "by studying their direct physical interaction with the world" (Black 2010, 178), Black's sculptures connote a psychoanalytic setting for the investigation of behaviour. And, if nothing else, the titles of Black's works, such as *Contact Isn't Easy*, *Acceptance Changes Nothing*, *Pretend to Prefer*, or *What to Ask of Others*, suggest a psychological subtext that makes reference to one's own internal state and its interaction with the environment, including human and non-human beings.

The relationship between epistemic objects and technical conditions in works by Black and Canell becomes even more complex and multilayered if we take into account that the installations mentioned work with model substances or are to be seen in large part as model systems for transformational processes or for interactions between the material environment and the human being. According to Rheinberger, models occupy a middle position

14 Because this is not explicitly verbalised or mutually inquired into by exhibition visitors, the viewer, however, seems to linger in the status of the undefined epistemic object without real insight from within or without.

between epistemic things and technical conditions. On the one hand, a model is established to such an extent that it can act as a promising "research attractor" (see Rheinberger 1997, 101). On the other hand, it has not been stabilised and standardised to the point that it can serve as a component of routine technology in a simple and unproblematic way. In this respect, both Black's sculptures and the structures and substances in Canell's works alternate between experimental conditions and epistemic objects and ultimately make a clear distinction between these two categories impossible.

ART AS AN EXPERIMENTAL SYSTEM?

As suggested at the beginning of this essay, at a certain level of abstraction fundamental similarities can be traced between the experimental scientific system and the visual arts in general—at least in recent art history. These similarities include, for example, working by means of a series of experiments or pursuing the openness or "*différance*" that affords a certain possibility for variation in experimental or artistic practice, which is, in turn, the condition needed in order that anything new be produced in the first place.[15] However, more insights follow if one probes more deeply into the individual structures that Hans-Jörg Rheinberger proposes for experimental scientific systems and inquires into the specific artistic analogues for representations, the various agents, and the interactions between (technical) conditions and epistemic objects. Contemporary works by the New Materialists feature such analogues, as has been demonstrated with respect to works by Karla Black and Nina Canell. What connects these works of art is an indexical representation that works with models and causes the investigated phenomena themselves to talk. Matter and material often appear to be raw, tentative, and processual, and in this way they disclose their recalcitrance and agency, which makes them resistant to approaches with arbitrary interpretations. While experimental scientific systems were primarily cited, reflected, and deconstructed in art of the 1990s and the early 2000s,[16] contemporary works by the New Materialists may themselves be considered experimental systems. They bring into view the features, performance, and aggregate states of the materials they use, the agency of matter and things or the fundamental principles of transformation processes, and also the multilayered interactions between the material environment and the human being. At the same time they also serve to expand and scrutinise artistic media themselves, which in the case of the New Materialists often consist in part of unaltered raw materials from everyday life or materials that are formless and enmeshed in processes. These thus pose questions about their relation to reality and their inherent potential for having an effect, as well as about the essential basic elements of artistic works.

15 There is also the uncertainty of an experimental result. "The experiment is, as it were, a search engine but with a curious structure: it produces things about which one can only say afterwards that one had to have been searching for them" Rheinberger (2007, 86).

16 See Witzgall (2007, in particular 100 onward).

REFERENCES

Arts Council Collection. 2011. "Structure and Material: Claire Barclay, Becky Beasley, Karla Black." Film made by William Simpson. YouTube video, 6:13. Accessed 3 November 2012. http://www.youtube.com/watch?v=tsHe7cb_DKo. Published in conjunction with the exhibition of the same name, shown at Longside Gallery, Yorkshire Sculpture Park, Spike Island Bristol, and The New Art Gallery Walsall.

Bachelard, Gaston. 1988. *Der neue wissenschaftliche Geist*. Translated by Michael Bischoff. Frankfurt am Main: Suhrkamp. First published 1934 as *Le nouvel esprit scientifique* (Paris: Alcan).

Belliger, Andréa, and David J. Krieger. 2006. "Einführung in die Akteur-Netzwerk-Theorie." In *ANThology: Ein einführendes Handbuch zur Akteur-Netzwerk-Theorie*, edited by Andréa Belliger and David J. Krieger, 13–50. Bielefeld: Transcript.

Bennett, Jane. 2010. *Vibrant Matter: A Political Ecology of Things*. Durham, NC: Duke University Press.

Black, Karla. 2007. "Open Frequency: Karla Black; Statement." Axis: The Online Resource for Contemporary Art. Accessed 3 November 2012. http://www.axisweb.org/ofSARF.aspx?SELECTIONID=34.

———. 2010. "Heike Munder in Conversation with Karla Black." In *Karla Black: It's Proof That Counts*, edited by Annette Hans, 175–179. Zurich: JRP / Ringier. Published in conjunction with the exhibitions *Karla Black*, shown at the Migros Museum für Gegenwartskunst, Zurich; *Karla Black (with Works by Kostis Velonis)*, shown at Der Kunstverein, Hamburg; *Karla Black*, shown at Modern Art Oxford; and *Karla Black: Sculptures (with Paintings by Bet Low)*, shown at Inverleith House, Royal Botanic Garden Edinburgh.

———. 2011. "Karla Black Talks about Her Exhibition at the 54th Venice Biennale." Produced for The Fruitmarket Gallery, Edinburgh. YouTube video, 2:31. Accessed 3 November 2012. http://www.youtube.com/watch?v=0maPSIkhosM. Published in conjunction with the exhibition *Karla Black*, shown at Palazzo Pisani as part of the 54th Venice Biennale.

Bois, Yve-Alain, and Rosalind E. Krauss. 1997. *Formless: A User's Guide*. New York: Zone Books.

Bono, Melanie. 2010. "A New Alchemie?" In *Neue Alchemie: Kunst der Gegenwart nach Beuys*, edited by Melanie Bono, 15–24. Cologne: Wienand. Published in conjunction with the exhibition of the same name, shown at LWL, the Landesmuseum für Kunst und Kulturgeschichte, Münster.

Coole, Diana, and Samantha Frost, eds. 2010. *New Materialisms: Ontology, Agency, and Politics*. Durham, NC: Duke University Press.

cx centre for interdisciplinary studies. 2013. "Macht des Materials / Politik der Materialität." Akademie der Bildenden Künste München. Accessed 14 January. http://www.adbk.de/Studium/lehrangebot/cx/cx.jahrestthema_2012_13.php.

Dander, Patrizia, and Julienne Lorz. 2012. "Skulpturales Handeln / Sculptural Acts." In *Skulpturales Handeln / Sculptural Acts*, edited by Patrizia Dander and Julienne Lorz, 16–20. Ostfildern, Ger.: Hatje-Cantz. Published in conjunction with the exhibition of the same name, shown at the Haus der Kunst, Munich.

Dolphijn, Rick, and Iris van der Tuin. 2012. *New Materialism: Interviews and Cartographies*. Ann Arbor, MI: Open Humanities Press.

Fisher, Elizabeth. 2009. "Material Intelligence." Kettle's Yard. Accessed 3 November 2012. http://www.kettlesyard.co.uk/exhibitions/mi_catalogue/essay_fisher.html. Published in conjunction with the exhibition *Material Intelligence*, shown at Kettle's Yard, London.

Galerie Barbara Wien. 2008. "Nina Canell: *Walking on No-Top Hill*." Barbara Wien, Wilma Lukatsch: Galerie und Buchhandlung für Kunstbücher. Accessed 3 November 2012. www.barbarawien.de/gallery/10102008241220 08.html. Published in conjunction with the exhibition of the same name, shown at Galerie Barbara Wien, Berlin.

Griffin, Jonathan. 2008. "Karla Black:

Sculpture, Vivid Provocations and a Mistrust of Language." Frieze 117 (September): 168–69.

Humanities Research Center. 2013. "Materialism and New Materialism across the Disciplines." Humanities Research Center, Rice University. Accessed 13 January. https://hrc.rice.edu/materialism.

Jones, Rachel. 2009. "Making Matters." Kettle's Yard. Accessed 26 September 2012. http://www.kettlesyard.co.uk/exhibitions/mi_catalogue/essay_jones.html. Published in conjunction with the exhibition *Material Intelligence*, shown at Kettle's Yard, London.

Latour, Bruno. 1996. "Do Scientific Objects Have a History? Pasteur and Whitehead in a Bath of Lactic Acid." Translated by Lydia Davis. *Common Knowledge* 5 (1): 76–91.

Mac Giolla Léith, Caoimhín. 2010. "Small Gestures, High Voltage." In *Evaporation Essays on the Sculpture of Nina Canell*, edited by Melanie Bono and Annette Hans, 28–40. Berlin: Distanz. Published in conjunction with the exhibitions *Nina Canell: The New Mineral*, shown at Neuer Aachener Kunstverein, and *Nina Canell: Five Kinds of Water*, shown at Der Kunstverein, Hamburg.

Rheinberger, Hans-Jörg. 1992. *Experiment, Differenz, Schrift: Zur Geschichte epistemischer Dinge*. Marburg an der Lahn: Basilisken-Presse.

———. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

———. 2006. *Experimentalsysteme und epistemische Dinge: Eine Geschichte der Proteinsynthese im Reagenzglas*. Translated by Gerhard Herrgott. Frankfurt am Main: Suhrkamp. First published as Rheinberger 1997.

———. 2007. "On the Art of Exploring the Unknown." In *Say It Isn't So: Art Trains Its Sights on the Natural Sciences*, edited by Peter Friese, Guido Boulboullé, and Susanne Witzgall, 82–93. Heidelberg: Kehrer Verlag. Published in conjunction with the exhibition of the same name, shown at the Weserburg, Museum für moderne Kunst, Bremen.

———. 2012. "Experimental Systems: Difference, Graphematicity, Conjuncture." In *Intellectual Birdhouse: Artistic Practice as Research*, edited by Florian Dombois, Ute Meta Bauer, Claudia Mareis, and Michael Schwab, 89–99. London: Koenig Books.

Roelstraete, Dieter. 2010. "Nina Canell Plus Electricity." In *Nina Canell: To Let Stay Projecting as a Bit of Branch on a Log by Not Chopping It Off*, texts by Dieter Roelstraete and Karl Lydén, 61–79. Cologne: Walther König. Published in conjunction with the exhibition of the same name, shown at Museum Moderner Kunst Stiftung Ludwig Wien.

Schawelka, Karl. 2002. "'More Matter with Less Art'? Zur Wahrnehmung von Material." In *Material in Kunst und Alltag*, edited by Monika Wagner and Dietmar Rübel, 13–32. Hamburger Forschungen zur Kunstgeschichte 1. Berlin: Akademie Verlag.

Seyfarth, Ludwig. 2011. "Good Vibrations." *Artnet*, 29 April. Accessed 18 October 2012. http://www.artnet.de/magazine/gallery-weekend-berlin-nina-canell-bei-konrad-fischer-und-wien-lukatsch/.

Witzgall, Susanne. 2007. "Science in the Showcase: The Artistic Treatment of a Cultural Guidance System." In *Say It Isn't So: Art Trains Its Sights on the Natural Sciences*, edited by Peter Friese, Guido Boulboullé, and Susanne Witzgall, 94–112. Heidelberg: Kehrer Verlag. Published in conjunction with the exhibition of the same name, shown at the Weserburg, Museum für moderne Kunst, Bremen.

Whatever Remains, However Improbable

British Experimental Music and Experimental Systems

Virginia Anderson
Experimental Music Catalogue

John Cage famously defined "experimental music" in this way: "the word 'experimental' is apt, providing it is understood not as descriptive of an act to be later judged in terms of success or failure, but simply as of an act the outcome of which is unknown" (Cage 1955, 13). Cage's definition implies that the "act" is not only a deed, but also provocation designed to elicit a response, or a generalised unit of research that results in an outcome (albeit an unknown one). In a way, this description of an "act" recalls Hans-Jörg Rheinberger's "description of experimental systems as the material arrangements within which I see the game of modern scientific knowledge production taking place" (Rheinberger 2003, 623). Cage distinguished between serial music (composition using a predetermined "ordering of the elements," which are then fixed in the score for the performer to play) and experimental music: chance (composition using random methods to order elements, which are similarly fixed for performance) and indeterminacy (composition that leaves some musical elements free for the performer to complete). Serial music, for Cage (1955, 13), was "a question of making a thing upon... which attention is focused," which is the autonomous artwork. In experimental music, however, the listener's "attention moves towards the observation and audition of many things at once, including those that are environmental—becomes, that is, inclusive rather than exclusive—no question of making [a thing], in the sense of forming understandable structures, can arise (one is [a] tourist)" (ibid.). Experimental music composition involves observing and incorporating events and materials that appear in the process of making (it is inclusive). In other composition the work is built from chosen materials (it is exclusive). Cage implies that this process is a journey in which the composer and listener accept materials and sources that appear whilst moving on, like a tourist on a package holiday.

Michael Nyman's book *Experimental Music: Cage and Beyond* opens with Cage's definition of experimental music. This book presents a history and theory of

not only American (Cagean) experimental music, but also British experimental music, a movement founded by Cornelius Cardew. The latter's leading composers and performers include John White, John Tilbury, Gavin Bryars, and members of the Scratch Orchestra, a group of musicians and non-musicians who created and performed indeterminate music. The British movement's stylistic and technical features are far more varied than Cage had envisioned in 1955. They include chance and indeterminacy, presented in common-practice notation as well as graphic and text notations; they also include improvisation, both in compositions and in more conceptual activities that, though musical, are not compositions (two non-compositional categories of Scratch Orchestra musical activities, Improvisation Rites and Research Projects, will be discussed later). These activities also include minimal composition of two distinct (and contrary) types. The first is "minimal" minimalism, in which very few events are presented either as drones or separated by silence. Howard Skempton, the foremost British "minimal" minimalist, has created short, sparse piano pieces since 1967. The second type is repetitive process minimalism. British repetitive process minimalism includes music that either uses chance processes (John White's Machine pieces) or systems music (developed by White and Christopher Hobbs), which employs repetitive processes that are generated by number systems. Systems pieces can be as fixed in composition as serial music. Finally, after 1970 British experimentalists (including Hobbs, White, Skempton, Dave Smith, and Hugh Shrapnel) began to write tonal pieces that revisited older musical styles in what Nyman called the "new tonality" and "a 'cult of the beautiful'" (Nyman [1974] 1999, 157). Examples such as Bryars's *The Sinking of the Titanic* (1969–) and Hobbs's *No One May Ever Have the Same Knowledge Again* (1994–), which use tonality, will be discussed later.

Since Nyman's book was published, the British movement has become less unified. Their stylistic and technical palette has largely shifted further away from Cagean indeterminacy (although it is still used) and further toward repetitive systems and postmodern tonality. These composers no longer mount joint concerts or write joint manifestos, as they did in the 1960s and 1970s. Yet their musical thinking is still more consistent as a group than with other British composers such as Steve Martland (a minimalist) or Christopher Fox (a post-1990s "new" experimentalist). Present-day music by the British experimentalists who appeared in *Experimental Music* still bear traces of Cage's "audition of many things at once" multiplicity, which cannot be found as easily in music by Martland or Fox. There is a strong sense that the British experimental composer exemplifies Cage's idea of the composer as a "tourist," as these composers set up stories, puzzles, and journeys and follow musically where they are led. They also share an artistic ethos. Nyman could not divorce experimental music from "the aesthetic, conceptual, philosophical, and ethical considerations that the music enshrines" (Nyman [1974] 1999, 2), any more than Rheinberger could divorce phenomena from concepts in experimental systems. The "experimental" ethos exists in "determinate" styles such as systems minimalism, and it can be shown, albeit anecdotally. For instance, White (1983) talks "about the delight in finding happy accidents among the numbers" in his strictest systems

pieces. Rather than trying to control the work and the performer, by creating, as Cage said, "a thing upon which attention is focused," White speaks as a tourist. He hopes for his system to surprise him when he converts the numbers into notes as much as he hopes for it to surprise the listener.

I will, however, focus on indeterminate composition in this chapter, as having more concrete "experimental" materials than systems music. I will examine the way that British experimental composers and other musicians saw scientific models in their music and parodied them, particularly the evocation of laboratory writing that occurs in Cardew's "opera book" *Schooltime Compositions* (1968) and the collection of Scratch Orchestra Improvisation Rites *Nature Study Notes* (1969b). I will also show how these composers pursued a rigorous research method whilst accepting fictional materials and concepts as its components; first, through the impossible journeys and expeditions of the Scratch Orchestra Research Projects and in Gavin Bryars's *The Sinking of the Titanic*; second, in the use of fiction and illogical thought, both in *The Sinking of the Titanic* and Christopher Hobbs's *No One May Ever Have the Same Knowledge Again*, a piece that takes astronomical theories (ranging from the naïve to the outright insane) sent by members of the public to Mount Wilson Observatory in Los Angeles and distributes them in a fictional, though scientifically conceivable, trip through the solar system.

Most of the following scores (both compositions and Improvisation Rites) are conceptually incomplete, comprising the "act" or "acts" that await their outcome in performance. The Scratch Orchestra Research Projects are slightly different from compositions and Rites. Not compositions *per se*, the Research Projects resemble museum or gallery exhibitions, or perhaps, because they are performed, academic conference presentations. Although the product of Research Projects is radically different to that of compositions and Improvisation Rites, their experimental systems are similar. Whatever musical technique they choose, British experimental composers and the musicians of the Scratch Orchestra begin with similar questions and amass similar kinds of data and concepts. In compositions and Rites, this enquiry becomes, at some point and for want of another word, the "score," which must then be completed in performance; in Research Projects, its materials form the stuff of the performance itself.

SCIENCE PROJECTS, THE EXPERIMENTAL WAY

A consistent theme of indeterminate experimental composition in Britain is its fascination with scientific method. This fascination may be expressed humorously. Cornelius Cardew's "opera book" *Schooltime Compositions* (1968) is a facsimile of a school composition book containing various "experiments" that resemble scientific illustration, instructions for experiments, and geometric figures, among freehand drawing, evocative prose, and short musical passages. Like his previous work *Treatise* (1963–67), which he constructed based on the linguistic symbolism of Wittgenstein's *Tractatus*, *Schooltime Compositions* has no instructions for performance. The performer has to supply data to complete

these pieces in order to play them. For example, "Making A" describes some sort of experimental (perhaps chemical) process involving A, B, and C. The score reads:

> When A in the A-gauge glass becomes level with white line, make more A as follows:
> 1. Place WET B in glass bamer.[1]
> 2. Empty one pack of A into the wet B.
> 3. Draw off two full measures of hot boiling C and pour them over the dry A in the B (using circular motion).
> 4. Draw off one FULL measure of A and repour it into B.
> 5. Close B between pours.
> 6. Never make more A if the A in A-gauge glass is above white line. (Cardew 1968)

The score never tells us what A, B, and C are, but we need not know what Cardew intended them to be, or whether "Making A" is a real experiment from which Cardew removed key words. Performers could choose any A, B, or C (actual or metaphorical) to complete and realise a correct performance of "Making A," as long as they observe the instructions that do appear in the score.

Cardew parodied the life sciences when he, Howard Skempton, and Michael Parsons founded the Scratch Orchestra in London in 1969. The Scratch Orchestra welcomed all players, regardless of musical, or even artistic, experience. The Draft Constitution of the Scratch Orchestra mandates several types of composition and other activity, including compositions by the members themselves, free improvisation, research projects (about which more later), and Improvisation Rites (Cardew 1969a, 617 and 619). Most Improvisation Rites were not compositions: they were intended to set the scene for free improvisation rather than describe the musical sound itself.[2] In the first publication associated with the Scratch Orchestra, *Nature Study Notes* (1969), Improvisation Rites are categorised like student botany or biology trip notebooks, using coded classifications numbered in order of collection (Cardew 1969b, 2). Codes use the initials of the Mother (the Rite creator or collector, equivalent to a composer), followed by the Rite title in initials, and end with the collection number. Thus HMSVR48 is Hugh (M.) Shrapnel, *Vodka Rite*, number 48 in the collection (ibid., 6). In this Rite, players must perform some action (not necessarily a musical action) whilst drinking a large bottle of vodka. The participants must communicate with one another as part of the action, so that a performance of *Vodka Rite* could be a convivial evening spent in chatting and drinking vodka. The performance ends when either the vodka is drunk or the players are too drunk to continue. At the end of the collection are notes providing further information on the Rites, including the Father (marked F), who gave the Mother the idea for the Rite, other relatives, and an Ancestor or

1 Tilbury (2008, 376n56): "What is a 'bamer'? Presumably some kind of receptacle. At the time of publication I had still not uncovered the mystery of its substance and provenance."

2 In practice, some Rites described musical activities and gave instructions for sound. Howard Skempton's *Drum No. 1* (HSDNO1) describes instrumentation and gives instructions for beginning and varying a pulse.

Archetype (marked A), the person or idea that the Rite represents. Shrapnel's *Vodka Rite* has the following notes: "Father: Clement Freud [politician and bon viveur, grandson of Sigmund Freud]. Son: HMS [Hugh Shrapnel]. Holy Spirit: Vodka" (ibid., 14). Cardew wrote Nature Study Notes out in longhand "for reasons of economy," but this only adds to the image of a collection of field study notes, with the only printed information, the title, appearing in a square frame. Thus Nature Study Notes appears to be the results of a field study trip that was, in reality, never undertaken.

JOURNEYS: REAL AND IMAGINED

Indeterminate experimental activity parallels experimental systems activity most closely when it builds things, and the building process in indeterminate compositions is often playful. François Jacob (1998, 126) described the collection of unordered research notes as "night science": "a sort of workshop of the possible where what will become the building material of science is worked out." Rheinberger (2003, 626) mentions the creativity, even the artistry, of the experimenter "in this contact zone halfway between experiment and paper, where... the individual artistic potential of the research scientist finds its primary playground." Whilst White's systems and Machine pieces resemble Jacob's "day science" (perhaps "day art," the exhibition of a well-oiled machine), Cardew's incomplete experiment, "Making A," is analogous to "night science" (perhaps "night art"), because although this score consists of ordered instructions, A, B, and C have yet to be "filled in" by the performer to give it artistic meaning. The Research Project was perhaps the largest do-it-yourself "night art" Scratch Orchestra category. Research was "an activity obligatory for all members of the Scratch Orchestra, to ensure its cultural expansion" (Cardew 1969a, 619). Although members were to decide on the exact nature of their research, the Draft Constitution mandated that "the universe is regarded from the viewpoint of travel" (ibid.). Thus all research would lead to some kind of journey, and that journey would be taken in performance. *The Journey of the Isle of Wight Westward by Iceberg to Tokyo Bay* was an early Scratch Orchestra journey. The Fluxus artist and chemist George Brecht (working as Brecht & MacDiarmid Research Associates) had previously created a number of geographic projects associated with "translocation and delivery," including one proposal "for the translocation of land masses by harnessing them to icebergs" (Michael Parsons quoted in Tilbury 2008, 391). This provided the Scratch Orchestra with research grounding to propose to float an iceberg southward to the Isle of Wight (a small island in the English Channel), then to use the iceberg to move the island to Japan.[3] The results were given in the journey concert of 15 November 1969 at the Chelsea Town Hall. Here the Scratch Orchestra provided a densely textured improvisation based on their individual researches, Christopher Hobbs tolled a bell to warn ships of

3 Interestingly, the French company Dassault Systèmes recently advertised their role in providing 3D graphics for a project led by Georges Mougin to tow icebergs south to provide fresh water to areas of drought, a futurist scientific project that the Scratch Orchestra anticipated artistically (Dassault Systèmes 2012).

the island's movement, and Brecht lectured on "geographical, oceanographical, sociological, economic and other aspects" of the project (ibid.).

Another research project, performed on 23 November 1970 at the Queen Elizabeth Hall, London, was *Pilgrimage from Scattered Points on the Surface of the Body to the Brain, the Heart, the Stomach, and the Inner Ear*. As part of their research, the Scratch Orchestra watched a private screening of the film *Fantastic Voyage* (Fleischer 1966), about a team of scientists who are miniaturised and injected into the bloodstream of a patient. The Orchestra members chose to accompany the sites that they visited musically through thematic associations: the brain was represented by a performance of the bassoon part of Mahler's Sixth Symphony (1906), as Mahler was considered to be the most "cerebral" of composers; the heart by "Boom-Bang-a-Bang" (the UK Eurovision joint winner in 1969), referring to the singer's heartbeat when her lover comes near; the stomach by Tchaikovsky's "1812" Overture (1880), following Napoleon's dictum that an army marches on its stomach; and the inner ear by Terry Riley's landmark minimalist piece *In C* (1964), because it was based "on a predominately auditory experience" (Cardew 1970). Amongst interruptions from members protesting the journey and an instrumentation that included other members playing table tennis and "games," relevant pieces by Scratch Orchestra members were also played, including Michael Parsons's *Mindfulness Occupied with the Body* (texts from the *Visuddhimagga* of Buddhaghosa), Howard Skempton's Improvisation Rite HSTPR41 (*Three-Part Rite*: "Each player divides himself into three *equal* parts"), and Richard Ascough's *Rationalisation of Realisation* (Tilbury 2008, 421–22).

Each research project was presented like a themed concert rather than a performance of a single work. With one possible exception, Michael Parsons's *Expedition to the North Pole*,[4] no Scratch Orchestra Research Project created a score that could be mounted for repeat performance. The Research Project is therefore not a composition; if anything, it resembles an exhibition in which the participants are curators. Instead of a score, we are left with an assemblage of the materials: documents referring to planning the concert, visual and aural artefacts associated with the concert, and finally, the documentation of the event itself (its recording, written programme, and critical reviews). Unlike Research Projects, Gavin Bryars's *The Sinking of the Titanic* is a single musical composition, albeit an indeterminate one. As originally created for an exhibition at Portsmouth College of Art, its first version resembled a Research Project, consisting of "a single page of typed A4 paper, a kind of conceptual artwork describing the possibility of a piece" (Bryars 2012). However, in 1972, Victor Schonfield, a promoter and critic who was planning a concert of Bryars's music at the Queen Elizabeth Hall in London, remembered the conceptual

4 Michael Parsons's *Expedition to the North Pole* is both a staged-work "opera" produced with Max Eastley (1984) and a related choral piece (1988) about the contest to reach the North Pole in 1908–09. Both versions might be considered to be late, formal, and mainly tonal realisations of a Scratch Orchestra Research Project proposed by Parsons called *Journey to the North Pole* (Tilbury 2008, 391–92). This Project was not realised during the existence of the Scratch Orchestra, but it is the title of a contemporary film documentary about the Orchestra (Boenisch 1971–72).

Sinking of the Titanic and asked Bryars, "accepting that this is a kind of theoretical piece, what would it actually sound like if you did hear it? You imagine things when you're reading the written descriptions, but can you make other people hear what you're hearing?" (Bryars 2008). Bryars remade *The Sinking of the Titanic* as a composition, which focused on the statement by the radio operator Harold Bride that the ship's band played as the Titanic sank beneath the waves. He amassed copious material on the disaster, including the list of band members, the timing of the event from striking the iceberg to the sinking, pieces the band would have played (especially the final piece, the hymn "Autumn"), the probable instrumentation of the final performance, and personal taped interviews with the remaining survivors. This collection of materials, currently published by Schott, forms the score of *The Sinking of the Titanic*. Unlike Scratch Orchestra Research Projects, *The Sinking of the Titanic* is a score because it is published as a score. It is, however, closer to Jacob's "night science" than many compositions, being indeterminate as to performance. The collection—"an assemblage of materials relating to the famous marine disaster" (Hugill Thomson 1989, 725)[5]—can be altered and expanded whilst remaining *The Sinking of the Titanic*. Long before its publication by Schott, some of these materials were published as *The Sinking of the Titanic* in the composition journal *Soundings* (Bryars 1975a). The piece also exists in several different recordings (Bryars 1975b, 1990, 1995, 2007, 2009). The score has expanded over time to take in the discovery of the *Titanic* by Robert Ballard in 1985, its salvage in 1986 and after, and, most recently, the renewed historical interest associated with its centenary. Before Ballard's discovery, Bryars included an unworkable plan by its nominal "owner," Douglas Woolley, to float the Titanic to the surface using gas-filled bags once it was found; after its salvage, Bryars added a lament for bass clarinet to represent a set of bagpipes found amid the wreckage. Bryars's own performances of *The Sinking of the Titanic* include new material, new environments (a performance occurred in a water tower in Bourge), and collaborations with other musicians (including Aphex Twin and the sound artist Philip Jeck).

Bryars uses rigorous historical research methodology in creating and refreshing *The Sinking of the Titanic*. His interviews with survivors show good principles of oral history. They were made whilst survivors of the accident were still alive and formed some of the most comprehensive research on the disaster since Walter Lord's 1955 book *A Night to Remember* (Lord 1955). Bryars also took part in a musicological debate in the letters pages of *The Musical Times* about what the band played as the *Titanic* sank (Huston et al. 1973, 489). Even as Bryars's methodology is rigorous, he can include materials and resources that have doubtful veracity or logic. Bryars can use doubtful materials and resources because rather than writing history, he is creating a work of art, albeit using historical methods. This is a common practice in experimental music: the composer or interpreter adheres rigorously to whatever method he or she chooses, but the materials are chosen to effect an artistic outcome to a musical question, not to prove a scientific hypothesis. Thus Bryars is able to give as much weight

5 The writer's language here resembles Rheinberger's terminology.

to literary fiction as he does to historical fact; for instance, Morgan Robertson's novella *Futility* ([1898] 1998), which described the wreck of a ship called the *Titan* under similar circumstances to the *Titanic* some fourteen years later. Bryars can also present fact in a more indirect manner than a scientist or historian. Throughout the 1972 performance of *Sinking of the Titanic*, the composer John White did not play, but rather sat, dressed in chef's whites, quietly drinking. This referred to the chief baker of the Titanic, Charles Joughin, who having decided to drink whisky until he drowned, staggered off the ship into the water and survived. As we shall see, Bryars also accepted speculative theories about the disaster, some of which approach the fantastic or illogical.

HOWEVER ILLOGICAL (EPISTEMIC) THINGS MAY BE

As we can see, data used in *The Sinking of the Titanic* may be fictional or fantastic, but it is data nonetheless. The *Titan* exists as the central subject of Robertson's book and is concrete knowledge; Woolley's plan to raise the *Titanic*, although unworkable, exists. Such creativity recalls Rheinberger's emphasis on the activity of investigation when he quotes Frederick Holmes: "It is the investigations themselves which are at the heart of the life of an active experimental scientist. For him ideas go in and come out of investigations, but by themselves are mere literary exercises. [I]f we are to understand scientific activity at its core, we must immerse ourselves as fully as possible into those investigative operations" (Holmes quoted in Rheinberger 1997, 26). Like many artists, experimental composers engage in serious investigations using ideas that may not be scientifically supportable. This rigor is common in science fiction: the logic of Captain Nemo's expeditions in Jules Verne's books is not negated by the inability of contemporary science to realise them.[6] Detective fiction is also primarily concerned with rigorous logic.[7] Fictional detectives influenced Bryars's method of composition: "It's the question of investigation of research, which is how I go about making pieces" (Bryars 2004). The quintessential detective is, of course, Sherlock Holmes. Holmes's dictum, repeated in the novels and stories as often as Cage's definition of "experimental music" appears in *Silence*, is, "when you have excluded the impossible, whatever remains, however improbable, must be the truth" (Doyle 1890, 93). Bryars is a former member of the Sherlock Holmes Society of London, "which indulged in some very bizarre activities from time to time" (Bryars 2004). The Society's basic assumption is that Holmes is real, as are his cases, which are documented by his associate, Dr. Watson, who is also real. Using Holmes's dictum as a guide to their research, members search for explanations and proofs for all events in the "Canon" of stories and novels. In

6 Bryars wrote an opera, *Doctor Ox's Experiment* (1998), based on Verne's short story of the same name about a scientist's experiment with gas on a small Belgian town.

7 Fictional detectives referenced by experimental composers include Dorothy L. Sayers's Lord Peter Wimsey, whose adventure *The Nine Tailors* (1934) involved campanology (the English practice of bell ringing), which is a kind of folk version of systems music. M. P. Shiel's Prince Zaleski (1895), a sybaritic Russian aristocrat, appears in two related pieces by Bryars, *Pogglioli in Zaleski's Gazebo* (1977) and *Out of Zaleski's Gazebo* (1977–78).

the novels, a fictional detective uses real and rigorous investigative techniques to understand fictional crimes; in the Society, real members use real and rigorous investigative techniques to understand the fictional detective. It is not surprising that since its composers enjoy applying rigorous research to fictional situations, Holmesian references and tributes appear in British experimental music. For instance, the title of the Experimental Music Catalogue publication the *Verbal Anthology* is spelt out using cryptographic characters from the Holmes story "The Dancing Men" as a tribute. The encrypted title reflects the way that the pieces in the *Anthology*, which all use text notation, may be cryptic to traditional musicians.

Experimental musical method often appears as a type of Holmesian logic, using the methods of Holmesian scholarship. Just as the members of the Sherlock Holmes Society accepted one fiction as truth (Holmes's existence) and worked from that truth, experimental composers could choose to accept belief as truth. As mentioned before, some of Bryars's data is based in "conceptions rather than realities" (Bryars 2008). The basis of *The Sinking of the Titanic* lies in Harold Bride's statement that the band played "Autumn" from 2:15 a.m. until the ship sank five minutes later. But what was the orchestration? Bryars found that since the lifts stopped working after the Titanic collided with the iceberg, the band could not have brought a piano to their final concert. Bryars arranged this hymn for string sextet and created an electronically altered tape of the sextet to represent the band's sinking. Bryars admits that "technically, and physically of course, even if they manage to keep bowing for a little while, the strings would not vibrate, you would hear nothing (and of course they would not live long), but that seemed to me to be not particularly critical as the attempt to play the music means that they did generate at least some music" (ibid.). The hymn is slowed down to represent the time that the Titanic lay under water. Guglielmo Marconi, the developer of wireless telegraphy, held the view, late in life, that sounds never die and only become fainter; with "sufficiently sensitive equipment," he should be "able to hear Christ delivering the Sermon on the Mount" (Bryars quoted in Beaumont-Thomas 2009). Although he thought that Marconi "really lost it [his sense of reality]," Bryars said, "it's a really fantastic piece of wistful thinking" (ibid.). Adopting Marconi's belief that sound never dies, Bryars asked Keith Winter, lecturer in physics and music at Cardiff University, to make calculations about the acoustic properties and the deflection of sound from objects in deep water. Bryars used this information to alter the sound progressively in the tape of "Autumn" to reproduce the sinking string sextet. The tape then continues to play in its altered state until Bryars represents the recovery of the Titanic (using Woolley's proposal) or its salvage (after Ballard's discovery) by reducing the distortion (Bryars 2008). Bryars's solution not only is Holmesian but also reflects his involvement with 'pataphysics, which the French writer Alfred Jarry, who first promoted it, called "the science of imaginary solutions" (Jarry 1996, 21). The science of 'pataphysics is extra-metaphysical, often invoking relationships through puns.[8] Bryars was

8 For instance, 'pataphysics can be heard (and interpreted) as "pas ta physiques" (not your physics),

elected to the Collège de 'Pataphysique, "a society committed to learned and inutilious research" (Brotchie 1995, 77) and only learnt of it later (Barry 2012).

Although he is not a member of the Collège de 'Pataphysique, Christopher Hobbs's *Apres Schubert* (2000), from his series *L'Auteur se retire*, appears on a collection of 'pataphysical music (Various Artists 2005), and he applies rigorous research methods to fictive data in a similar way to Bryars. Unlike *The Sinking of the Titanic*, Hobbs's *No One May Ever Have the Same Knowledge Again* exists as a fixed traditional score (and an arranged variant), with little or no indeterminacy, but it is constructed experimentally. Hobbs explores theories appearing in letters written to scientists at Mount Wilson Observatory in Los Angeles after its opening in 1908. These letters were edited for a book of the same title by Sarah Simons as part of an exhibit at the Museum of Jurassic Technology in Los Angeles (Simons 1993).[9] The writers were "individuals who felt, often with a great degree of earnestness, that they were in possession of understandings or information that should be shared with the astronomers" (ibid., xii). In scientific terms, these understandings were, at the very least, impracticable. Hobbs recorded readings of extracts from these letters, dispersing them along a flight path from the sun to Pluto over twenty-eight minutes (Hobbs notes that this represents a speed of Warp 2.25 in *Star Trek* science). Along the way, the recorded voices tell their secrets to the listener: "the sunspots you can see on the sun are that very black cloud, which is called a verandah," and "I want to reveal that innermost secrets of Mars which are puzzling the scientists the world over" (Hobbs 2001, 76). Each time a planet is passed, Hobbs quotes relevant passages from Holst's *The Planets* (1914–18, the time of many of the Mount Wilson letters), but he hides these quotations within his own, original material (based on numerical manipulations of scale systems in proportion to planetary distances). Hobbs "cheats" the research to create his own fiction only once, when he places a *pizzicato* passage (representing asteroids) in the section linking Saturn and Uranus. He reveals this unusual inaccuracy: "Astronomy teaches us that the Asteroid Belt lies between the orbits of Mars and Jupiter. But not in this work" (ibid., 30), referring to Samuel Beckett's novel *Watt*. Under the text "Sam's unmarried daughter Kate" was "a fine girl, but a bleeder," Beckett added the footnote, "Hemophilia is, like enlargement of the prostate, an exclusively male disorder. But not in this work" (Beckett [1953] 1959, 102). Had Hobbs or Beckett written fantastic fiction, the sun could be binary or a giant peach and Kate could bleed purple peanut butter, but Hobbs and Beckett must excuse the few fictions they create themselves, even as they accept them willingly from others. As the journey continues, Hobbs increasingly uses recorded short-wave radio sounds rather like Bryars deploys his endless string sextet. "Radio waves are, theoretically, eternal; all radio waves which emanate from the earth may continue through the galaxy forever" (Hobbs 2001, 20). The piece fades to radio sounds and silence.

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among other variants.

9 The Museum of Jurassic Technology, curated by David Wilson, also applies real research to a "strange half-world between fact and fantasy" (Hobbs 2001, 14).

The point at which an experimental composition can be considered to be "complete" depends on the composer and his or her compositional method. Sometimes, as in *No One May Have the Same Knowledge Again*, the composition is notated before performance in almost a traditional manner. The score is a report of Hobbs's research, derived from what Rheinberger calls "a sophisticated experimental constellation" (Rheinberger 2003, 624).[10] Sometimes, as in Gavin Bryars's *The Sinking of the Titanic*, the final composition presents the traces and activities themselves: a collection of research data to be collated, "written," and released by performers as experimental colleagues. And in a few cases, such as the Scratch Orchestra Research Projects, performers, given only the topic, have to amass the traces and create the experimental activity themselves. The acquisition of knowledge in experimental music can extend to reception. Unless they are informed, a listener could not tell that *Schooltime Compositions* has a score whilst *Journey of the Isle of Wight* does not. A listener to an indeterminate piece might not know whether the composer "composed" musical material or whether the performers created it in their "interpretation."[11] The soothing concords of most performances of *The Sinking of the Titanic* belie the reality that this piece is a collection of research materials to be put together for performance, sounding, as it usually does, like Bryars's fully-written-out later work. Finally, at a late stage in drafts of this chapter, Hobbs, who had told me that the 1994 score of *No One May Ever Have the Same Knowledge Again* was definitive and that there would be no other versions, produced an indeterminate version for a concert in March 2013 in Nottingham using the same materials. Hobbs had previously given himself permission to do so in 2001, although he had rejected it sometime afterward. "I would not preclude the idea of altering the instrumentation again for subsequent performances; there is in a sense no 'definitive' version of the score but rather, within the limitations of the systems and structure I have described above, a universe of unexplored possibilities" (Hobbs 2001, 32). Because the research materials are the same, and the flight is the same, one wonders how the listening experience will differ from the fixed score in its indeterminate version.

Cage's experimental "act" could be seen as a single test or experiment, either as part of a larger, composite project or as an event in its own right. Improvisation Rites from *Nature Study Notes* and individual pieces in Cardew's *Schooltime Compositions* are single "acts," tests and/or experiments leading directly to a performance outcome. Hobbs's exploration of the solar system, Bryars's sinking and salvage of the *Titanic*, and Scratch Orchestra research projects are composite research projects comprised of observations, experiments, and collections of materials necessary to effect the performance outcome. In both types of music, the musical content does not underscore the project; it is

10 Since Hobbs is writing about the solar system, the word "constellation" is particularly appropriate for his collection of data.

11 When I performed the speaker's role in Barney Childs's *Sunshine Lunchh & Like Matters* (1983) for bass clarinet and speaker, an audience member approached me, concerned by what she saw as Childs's "obsession with death." I had personally inserted the "death"—extracts from an article on the cookery of unusual game—into indeterminate sections of Childs's score.

a component of the project. For example, the American composer Jim Fox also set the book *No One May Ever Have the Same Knowledge Again* in the piece "The Copy of the Drawing." Fox sets the words of the Mount Wilson correspondents over brooding electronic drones to make a static sonic film noir scene (Fox 2001). In contrast, the informants in Hobbs's piece become docents on the journey through the solar system, just as the informants in *The Sinking of the Titanic* provide evidence of Bryars's research.

For all their acceptance of suspect data, Hobbs's and Bryars's pieces, in performance, feel authentic due to their research methodology. They are closest to the logic games of early twentieth-century French art, particularly the music of Erik Satie and Jarry's 'pataphysics. This use of fictive data is also peculiarly British, as Cardew and the Scratch Orchestra were influenced by the British use of illogic and fantasy, ranging from Jonathan Swift to *Alice in Wonderland*, to music hall comedy, and to Monty Python. Thus although scientific experimental systems and British experimental musical systems differ little in the framework and activity of their methodology, British experimentalists accept fictive data equally with concrete data. If a scientific research project were based on this fictive data, it would transgress scientific method and could not be tolerated. For the British composers, fictive data is not only relevant but also, it would seem, necessary to the creation of the experimental art.

REFERENCES

Barry, Robert. 2012. "A Quietus Interview: The Exploits and Opinions of Gavin Bryars, 'Pataphysician." *The Quietus*, April 12. Accessed 30 April 2013. http://thequietus.com/articles/08491-gavin-bryars-interview.

Beaumont-Thomas, Ben. 2009. "*Sinking of the Titanic*: The Watery Meditation Continues." Unpublished longer version of the blog post "*Sinking of the Titanic*: The Watery Sound Meditation Returns," *The Guardian*, 8 May, http://www.guardian.co.uk/music/musicblog/2009/may/08/sinking-titantic-gavin-bryars.

Beckett, Samuel. (1953) 1959. *Watt*. New York: Grove Press.

Boenisch, Hanne, director. 1971–72. *Journey to the North Pole*. Munich: Bavarian Television.

Brotchie, Alistair, ed. 1995. *A True History of the College of 'Pataphysics*. London: Atlas Press.

Bryars, Gavin. 1975a. *The Sinking of the Titanic* (score). *Soundings* 9 (February): n.p.

———. 1975b. *The Sinking of the Titanic*. Obscure Records, Obscure 1, LP. Re-released on *The Sinking of the Titanic; Jesus' Blood Never Failed Me Yet*, Virgin, CDVE 938 7243 8 45970 2 3, 1998, compact disc.

———. 1990. *The Sinking of the Titanic*. Crépuscule, TWI 922–2, compact disc.

———. 1995. *The Sinking of the Titanic*. Point, 446–061–2, compact disc.

———. 2004. Interview by Robert Worby. BBC Radio 3 website. Accessed 30 April 2013. http://www.bbc.co.uk/radio3/newmusic/ram/negiliv_web4.ram.

———. 2007. *The Sinking of the Titanic*. Touch, Tone 34, compact disc.

———. 2008. Unpublished interview by Bob Gilmore. Dartington College, Devon, 26 November.

———. 2009. *The Sinking of the Titanic: Live Bourges 1990*. LTM, LTMCD 2525, compact disc.

———. 2012. Email to Virginia Anderson, 27 November.

Cage, John. 1955. "Experimental Music: Doctrine." In *Silence: Lectures and Writings*, 1961, 13–17. Middletown, CT: Wesleyan University Press. First published as "Experimental Music" in *The Score and I.M.A. Magazine*.

Cardew, Cornelius. 1968. *Schooltime Compositions*. London: Experimental Music Catalogue.
———. 1969a. "A Scratch Orchestra: Draft Constitution." *The Musical Times* 110 (1516): 617 + 619.
———, ed. 1969b. *Nature Study Notes*. London: Experimental Music Catalogue.
———. 1970. Unpublished Scratch Orchestra letter, July. Private collection.
Dassault Systèmes. 2012. "Ice Dream." Dassault Systèmes. Accessed 30 April 2013. http://www.3ds.com/icedream/.
Doyle, Arthur Conan. 1890. *The Sign of the Four*. London: Spencer Blackett.
Fleischer, Richard, director. 1966. *Fantastic Voyage*. Written by Jerome Bixby, Otto Klement, Harry Kleiner, and David Duncan. Twentieth-Century Fox.
Fox, Jim. 2001. *Last Things*. Cold Blue Recordings, CB0001, compact disc.
Hobbs, Christopher. 2001. "On the Musical Compositions of Christopher Hobbs." PhD thesis, De Montfort University.
Hugill Thomson, Andrew. 1989. "'The Apprentice in the Sun': An Introduction to the Music of Gavin Bryars." *The Musical Times* 130 (1762): 724–28.
Huston, John, Ronald Johnson, George Fill, and Gavin Bryars. 1973. "Titanic" (letters to the editor). *The Musical Times*, 114 (1563): 489.
Jacob, François. 1998. *Of Flies, Mice, and Men*. Translated by Giselle Weiss. Cambridge, MA: Harvard University Press.
Jarry, Alfred. 1996. *Exploits and Opinions of Dr. Faustroll, Pataphysician*. Translated by Simon Watson Taylor. Boston, MA: Exact Change.
Lord, Walter. 1955. *A Night to Remember*. New York: H. Holt.
Nyman, Michael. (1974) 1999. *Experimental Music: Cage and Beyond*. London: Studio Vista. 2nd ed., Cambridge: Cambridge University Press. Citations refer to the 2nd edition.
Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.
———. 2003. "Scrips and Scribbles." *MLN* 118 (3): 622–36.
Robertson, Morgan. (1898) 1998. *Futility* [*The Wreck of the Titan; or, Futility*]. First Centenary Edition. London: Pigeon Bob & Berry.
Simons, Sarah, ed. 1993. *No One May Ever Have the Same Knowledge Again: Letters to Mount Wilson Observatory, 1915–1935*. West Covina, CA: Society for the Diffusion of Useful Information Press.
Tilbury, John. 2008. *Cornelius Cardew: A Life Unfinished*. Matching Tye, UK: Copula.
Various Artists. 2005. *'Pataphysics*. Curated by Andrew Hugill. Sonic Arts Network, SAN2005, compact disc.
White, John. 1983. Interview by Virginia Anderson. London, 2 March.

Of Arnold Schoenberg's *Klavierstück* op. 33a, "a Game of Chess," and the Emergence of New Epistemic Things

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ARTISTIC RESEARCH AND EXPERIMENTATION: GAMES, RULES, AND THE OPPORTUNITIES OF THE UNSOLVED

Artistic research is evolving as a field in which, among other questions, we can ask whether the problems posed by complex and challenging musical compositions are necessarily intended to find fully satisfying resolution in any given performance—or even, for that matter, in the collective sum of all their performances. Whilst traditional musicological research may also pose this question from a theoretical standpoint, the open, experimental research-cum-performance space of the artist-researcher allows it to be addressed in different, more empirical ways. Moreover, a public performance that both builds upon and extends such experimentation, presenting the question as integral to the interpretation, may ultimately have more to contribute to an audience's appreciation than one that defuses unsolved elements through seeking an interpretation in which all internal conflicts are, supposedly, neutralised.

The concept of the "unsolved performance," at first sight an unappealing prospect to the ticket-purchasing concertgoer, on closer inspection reveals itself as potentially capable of delivering greater value—and, perhaps, longer-lasting impact—than its counterpart, whose resolution may be contrived or illusory. The performative tracing of compositional problems proposes a degree of co-creativity from audiences, offering them partnership with performers and composers, rather than a pleasurable but intellectually disengaged passivity.

Within this renegotiated concert setting, performances can take on the character of complex, speculative "games," in which gambits are deployed that, as the performance unfolds, may lead to victory, defeat, or stalemate, but where any of these outcomes still make the witnessing of the game's unfolding

worthwhile. Analogies between music and chess are by no means novel; but, in this chapter, I am encouraged to add to their number because the particular case I shall be examining—that of Arnold Schoenberg—presents us with an individual who, as it turns out, was no less innovative and challenging in his chess-game creations than in his compositions. I shall suggest that deepening one's understanding of his creative inventions in both domains may divulge strategies for "unsolved" but gratifying realisations of his musical works.

Since I shall be discussing experimentation, I should acknowledge at the outset that the "ontological flashes" that are associated with new insights within experimentation are to be found more readily in the unexpectedness that musical performance affords us than in moves within a chess game. Within chess, one may have insights that allow one to perceive novel moves that will lead to winning the game, but one's insights cannot change the game itself; the transformative nature of the unforeseen is thus circumscribed. In performance, however, we may find means of acting on the insights gained though experiment, refreshing and transforming our practice with fundamentally new approaches. Performance is therefore more consummately the kind of experimental situation that Hans-Jörg Rheinberger would recognise: "Experimental systems are thus impure, hybrid settings ... [They] must be capable of differential reproduction ... in order to behave as devices for producing scientific novelties that are beyond our present knowledge, that is, to behave as 'generator[s] of surprises'" (Rheinberger 1997, 2–3).[1] Despite this caveat, I shall hope to show that, in the case of the music I shall be discussing, the conflation of chess and composition within a discussion of "unsolved" music performance actually offers fruitful insights on both the literal and metaphorical level; not only do Schoenberg's inventions in the realm of chess offer an intriguing sidelight on his compositional strategies but also the metaphor of chess itself, provided it is understood to be only a metaphor, becomes a way of reconciling the predetermined and the unforeseeable within the conceptual experimental set-up.

Arnold Schoenberg: Compositional Control and the Performer's Response

In the 1920s, following a period of apparently decreased productivity precipitated by both the privations of wartime and a personal creative crisis in his development as a composer,[2] Arnold Schoenberg re-emerged as an artist in the

1 Here Rheinberger cites Mahlon B. Hoagland (1990, xvii).

2 The apparent slowing, or blocking, of Schoenberg's creative momentum is discussed in a number of secondary writings, notably "Silence, Order, and Terror 1914–1933" by Allen Shawn (2002). However, an examination of the chronology of Schoenberg's work at this time that goes beyond considering completed compositions uncovers a more complex picture. There are, indeed, several incomplete and fragmentary items: a "Choral Symphony" fragment (1914), text for *Die Jakobsleiter* (1915–16), and incomplete work on the Second Chamber Symphony; but the Four Orchestral Songs, op. 22, were completed in 1916. Furthermore, Schoenberg served in the Austrian Army for a period of time (1915–16) before being medically discharged. Given his previous, intense productivity in the pre-war years, from 1908–12 in particular, the perception of a loss of momentum is not surprising. This account of some of the practical reasons does not replace the sense of a genuinely existential set of problems faced by Schoenberg during this time, but it shows that, for Schoenberg, the practical and tangible stood very closely indeed to the abstract aspects of creativity.

throes of potent reinvention. His engagements with the organisation of musical material and his consequent development of "composition with twelve tones," were but musical instances of how the evolution of his entire worldview touched most of what he created and formed an apparently unifying field of possibilities. Another example is his development during the same period of his "Coalition Chess" game, a kind of "super chess," played from all four sides, in which the conventional pieces of the traditional game are replaced by planes, tanks, artillery, and other icons of twentieth-century warfare.[3]

Through study of Schoenberg's compositional processes during this time, as well as scrutiny of his creation of physical objects (such as his chess pieces, formed from bits of cardboard, wood, paper, and string that might otherwise have been discarded), it is possible to assert that what Schoenberg formed for himself in each of these areas was a highly controllable metaphorical field within which he could conduct various kinds of experiments that had the capacity for concretisation, leading to verification or refutation (since many of them involved mathematical number games, formal constructional strategies through tone-row language, and other means of expressing an apparently external logic).[4] It is this capacity that has made Schoenberg's twelve-tone music something of a magnet for music scholars and analysts. However, it has made it more challenging for performers to engage with material in which compositional determinism seems so absolute and personal expression so circumscribed. Paradoxically, this makes the repertoire all the more fertile a terrain for the artistic researcher seeking to generate the kinds of practice-based approaches that might lead to greater illumination of the core musical material and to the potential development of new musical ideas, new modes of presentation—and even new knowledge. In such a process, the materials of practice-based experimentation have the potential to become "epistemic objects," characterised by "an incompleteness of being and the capacity to unfold indefinitely" (Knorr Cetina 2001, 180–81), creating *unsolved performances*. The apparent over-documentation of Schoenberg's music may thus be refreshed by the pleasures of a sensate, practice-based approach that welcomes the unforeseen, the "generation of surprise" within the performance, as an extension to Schoenberg's own experimental system, noted above.

To illustrate this, I will use a specific example from Schoenberg's piano works of the 1920s, the *Klavierstück* op. 33a, as a case study. I shall be examining how the performer's processes of experimentation, via such means as finger-

3 During 3–5 June 2004, the Arnold Schoenberg Center hosted a special exhibition and symposium, *Arnold Schoenberg's Brilliant Moves: Dodecaphony and Game Constructions*, in which original manuscripts of all of Schoenberg's twelve-tone works were displayed alongside practical artefacts for twelve-tone composition, designs for furniture, inventions (such as drawings for a typewriter for musical notation), and the Coalition Chess game itself, including the chess pieces. A volume of the proceedings of the symposium has been published (Meyer 2006), as has a catalogue of the exhibition (Meyer 2004).

4 Schoenberg's Coalition Chess is the focus for an online gaming community found at www.schoenbergchess.com. On this site, one can learn Schoenberg's rules for the game, the "Zaman-Strouhal variants," and the remarkable scope of the game's complexity, in terms of possible configurations. It is also possible to play games on the site. On 23 February 2004, the Arnold Schoenberg Center in Vienna hosted a trial game involving four chess grandmasters, who, "following initial scepticism … revealed that Schoenberg's game is relatively easy to learn" (Ehn and Strouhal 2004, 79).

ing, variable generation of sonorous "fields," and execution of phrasing, may be seen both to interface and be at odds with Schoenberg's own layers of experimentation—as evidenced, for example, through his process of sketching and generating row tables that are neither as "abstractly" detached from the musical compositions that they generate as one might initially assume, nor as determining of final compositional outcomes as one may infer through studying the secondary literature.[5] The aim will be to interrogate this process of experimentation as a potential crucible for new knowledge and to speculate upon the necessary modes of dissemination, including new approaches to practice and performance, that might be required for such knowledge.

One of the most important elements within this kind of reading is that the performer's own "gambits" *matter*; in artistic research, the performer can indeed evolve a profound technical knowledge of a work in order to "play the game" to its deepest level and even to "re-write the rules." As will be discussed in more detail later, this last possibility is in apparent contradiction to Schoenberg's own thinking about where the sole prerogative for rule-making lies in the composer-performer relationship. In a famous letter that I shall cite, he even comes close to suggesting that analysis is a field from which performers have nothing to learn and which they should therefore leave to composers. However, this should not stop us in our tracks—any more than an ambitious chess player should avoid an opponent likely to defeat them!

CHESS AS METAPHOR AND CULTURAL TROPE

Chess is a game like any other, with its hermetic system of pieces and moves, but it also features in an iconic way in many artistic genres. We learn of chess as a metaphor, as a set of signs for how we might conduct ourselves in confrontation, and we also see chess as a language game in which the cut and thrust of move and counter-move mirrors the polemical structure of argued discourse. It is a metaphor used to memorable effect in cinematic, televisual, and literary creations:

> Are we not guilty of offensive disparagement in calling chess a game? Is it not also a science and an art, hovering between those categories as Muhammad's coffin hovered between heaven and earth, a unique link between pairs of opposites: ancient yet eternally new; mechanical in structure, yet made effective only by the imagination; limited to a geometrically fixed space, yet with unlimited combinations; constantly developing, yet sterile; thought that leads nowhere; mathematics calculating nothing; art without works of art; architecture without substance—but nonetheless shown to be more durable in its entity and existence than all books and works of art; the only game that belongs to all nations and all eras, although no one knows what god brought it down to earth to vanquish boredom, sharpen the senses and stretch the mind. Where does it begin and where does it end? Every child can learn its basic rules, every bungler can try his luck at it, yet within that immutable little square it is able to bring forth a particular species of

5 See Auner (2010) for illuminating readings of the often less than orderly path from sketches and row materials to final outcomes in selected works of Schoenberg. This aspect of op. 33a, with Auner's contribution to the debate, is discussed below.

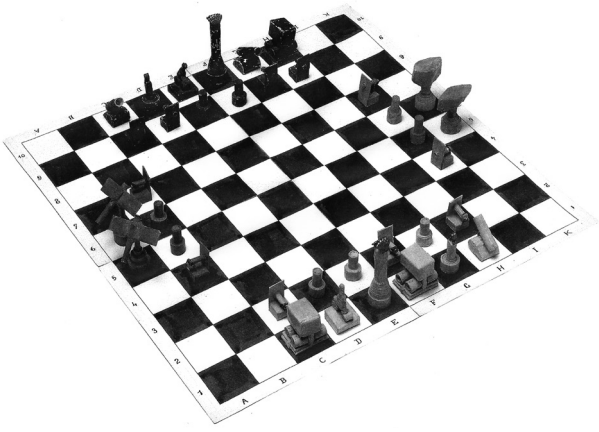

Fig. 1

> masters who cannot be compared to anyone else, people with a gift solely designed for chess, geniuses in their specific field who unite vision, patience and technique in just the same proportions as do mathematicians, poets, musicians, but in different stratifications and combinations. (Zweig 2006, 11–12)

Zweig's commentary suggests a way in which subservience to general rules can still, in the case of a sufficiently subtle game, allow for the decisive intervention of the creative imagination of the player. His eulogy on the mathematical, poetic, and musical analogies inherent in the traditional game is amplified when one considers artistic conjectures as to yet more subtle and complex variants:

> On a low table sits a very modern object, which I discovered was five chess-boards mounted one above another in a glass frame; there are chessmen on each board, as arranged for five different games in progress; the boards are made of transparent Lucite or some such material, so that it is possible to look down through them from above and see the position of every man ... (Davies [1972] 1983, 518)
> ... Each player plays both black and white. If the player who draws white at the beginning plays white on boards one, three and five, he must play black on boards two and four. I said ... that this must make the game impossibly complicated, as it is not five games played consecutively, but one game.
>
> [The reply]:
> Not half so complicated as the game we all play for seventy or eighty years. Didn't [your analyst] show you that you can't play the white pieces on all the boards? Only people who play on one, flat board can do that, and then they are in agonies trying to figure out what black's next move will be. Far better to know what you are doing, and play from both sides. (ibid., 532)

All these elements of chess—its modelling of power structures, its aesthetically compelling plastic qualities, its tests of logic, and its potential for risk—made it an obvious organisational vehicle for Schoenberg when he invented his own version of the game in 1921. The Austrian-American chemist, Carl Djerassi, also a novelist and playwright, but best known for his contribution to the development of oral contraceptive pills (and thus to "risk-reduction"), describes Schoenberg's "coalition chess" in an experimental piece of writing, as follows:

> Arnold Schönberg had invented a four-party chess game, coalition chess (*Bündnisschach*). The basic rules of the game are as follows. Two of the four players have

Figure 1. Coalition Chess, displayed in the Arnold Schoenberg Center, Vienna.

> twelve chess figures (yellow and black) at their disposal and are thus considered the two "big" powers, whereas the other two have only six figures (green and red), thus representing the "small" powers. After the first three moves, two "coalitions" ensue in that one of the small powers declares itself associated with one of the big ones. Thereafter the play continues until checkmate is reached. (Djerassi 2008, 2)

Schoenberg's chess game is part of his confrontation with—and use of—history.[Fig. 1] If standard chess cloaks its aggression in the stylised symbols and personages of a bygone age—kings, queens, knights, bishops, etc.—and plays out success and failure in straightforwardly dualistic dynastic conflict, Schoenberg's "coalition" chess is strategy and warfare with a contemporary face. The kings in this version of the game are modern monarchs with technologically equipped armies at their disposal and the capacity to broker alliances with other powers. The underlying message of the game is that the only recourse of the weak is to find powerful allies to protect them:

> Pieces for Coalition Chess, their moves and distribution:
> – (King) moves and captures as in chess and also has the same importance.
> – (Plane) is a new piece, it corresponds to two successive moves by the Knight. The only move which is not permissible is one that takes the "Plane" back to its starting position.
> – (Submarine) is also a piece which is not found in the game of chess. It is permitted to move in the same way as the Queen and Knight.
> – (Tank) corresponds to the queen in chess.
> – (Artillery) corresponds to the Rook.
> – (Engineer) corresponds to the Knight.
> – (Motorcyclist) corresponds to the Bishop in chess.
> – (Machine-gun) is a piece which is not found in the game of chess.It has the same rights as the King and Pawn, but can be captured without the player losing the game. Therefore, it can also move forward two squares from its starting position and can move one square in all directions to capture other pieces.
> – (Guard) corresponds to the Pawn in chess. (Zaman and Strouhal 2004, 76)

It may not be too far-fetched to suggest that, in the aftermath of defeat in 1918, and with the concomitant decline of the "old Austria" to which he felt considerable loyalty and which included canonical composers whom he revered, Schoenberg re-focussed his energies on the achievement of tangible outcomes within his own creative domains that also had ethical subtexts. Coalition Chess and "composition with twelve tones" share both concrete characteristics and ideological resonances, however ironic these may be, in their use of images of rigid protocol and tight, centralised control in the wake of devastating defeat in war. Similarly, Schoenberg's development of another stabilising set of rules in the Society for Private Musical Performances, which was inaugurated on 23 November 1918, becomes a sign that, as with the collapse of the old world and its certainty, so within the hierarchies associated with Western art music, a new "country" is needed, in which "citizenship" is determined by adherence to a set of ethical rules of conduct concerning how new "high" artworks should be experienced.[6]

6 See Bujic (2010, particularly 95–107, 108–34).

Schoenberg's utopian structures and statements are far more than reflections upon the process of composition. Is the following famous text from Schoenberg's essay "Composition with Twelve Tones" concerned with composition, or chess, or both and yet more?

> *The unity of musical space demands an absolute and unitary perception*. In this space ... there is no absolute down, no right or left, forward or backward. Every musical configuration, every movement of tones has to be comprehended primarily as a mutual relation of sounds, of oscillatory vibrations, appearing at different places and times. To the imaginative and creative faculty, relations in the material sphere are as independent from directions or planes as material objects are, in their sphere, to our perceptive faculties. (Schoenberg 1941, 223)

Schoenberg writes here of the "unitary perception," which can unite sounds appearing at different times, and likens it to the "perceptive faculties" that come into play when we contemplate material objects—a category that might well include chessmen and the multiple interactions of their possible moves. The standard chessboard and the serial row matrix that we use in the analysis of specific aspects of Schoenberg's music have many features in common. But in Schoenberg's coalition chess, and in the serial row matrix, the players/note-sequences move from all four sides, adding potential dimensions, increasing both potential risk and gain. Recalling Davies: "Far better to know what you are doing, and play from both sides" (Davies [1972] 1983, 532)—or in our case, from *all* sides.

PERFORMING FROM ALL SIDES

This multilateral way of working is becoming increasingly interesting to performers. Characteristically, Glenn Gould situated himself in the early vanguard of such informed performance practices, offering extended commentaries on the keyboard works of the Second Viennese School, and even prefacing his performances of serial compositions by playing the prime row of the work in question, something upon which Mitsuko Uchida comments in her own account of developing performances of Schoenberg's Piano Concerto, op. 42 (Arnold Schoenberg Center 2007).[7] This latter interview is significant for performers of Schoenberg's work, in that Uchida does *not* follow Schoenberg's apparently prohibitive injunctions concerning performers' recourse to music analysis; instead, she does something much better, which is to play with the tone-row material as a part of experiencing its manifold properties, exploring its intervallic "physiognomy" by touch and sound, and developing an intellectual, aesthetic, and emotional relationship with the material. Here, performance and analysis merge in a critical reading, full of poetry. Uchida becomes an ideal kind of Schoenberg performer—respectfully disobedient.

Uchida challenges us through her example to be similarly questioning in our own listening, interrogating what can be gleaned from even a small fragment

7 This interview with Uchida was filmed in association with her rehearsal of the work with Jeffrey Tate and the Rotterdam Philharmonic Orchestra.

such as the tone row. In an almost literal, as well as metaphorical, sense, she experiments with the row. In the opening passages of Schoenberg's music, this is important because, if we return to the chess metaphor, his opening bars, more than most, are opening gambits, which generally contain the row's prime material that, as Uchida demonstrates, opens the sound world of the work to us. Furthermore, performers who are mindful of the contradictions and ambitions of Schoenberg's life project are well placed to create links between the tacit world of his musical ideas and the words that have come to surround these, via the embodiment and temporal experience that form the milieu of performance. They can thus propose certain kinds of resistance to Schoenberg's more problematic utterances.

Among such statements must surely stand the much-discussed letter written by Schoenberg to the violinist Rudolf Kolisch, dated 27 July 1932. The letter was sent in response to correspondence in which Kolisch had discussed the tone-row material of the Third String Quartet, op. 30 (1927), as part of the Kolisch Quartet's preparations for a performance of the work:

> You have identified the tone rows of my string quartet correctly (except for one small point: the second consequent phrase reads: 6th tone = C sharp, 7th tone = G sharp). It must have taken a great deal of effort, and I do not think I would have had the patience. But do you think that knowing it serves any purpose? I cannot imagine how. I am convinced that for a composer who knows nothing whatever about using rows there is a stimulus in learning how he can proceed, a purely technical hint as to the row's potentialities. But aesthetic qualities are not disclosed in this way, or only incidentally. I cannot caution often enough that this kind of analysis must not be overestimated, because it leads only to what I have always fought against: to the knowledge of how something is *made*, whereas I have always helped people to realize what something *is* (Schoenberg 1932, 31)

There has been a considerable amount of literature dedicated to unravelling Schoenberg's intention in this letter,[8] but much of this has pertained to how the communities of music theory and analysis should respond, rather than the community of performers. As well as this being yet another manifestation of the marginalising of the performer's perspective, there are logical reasons why the letter should provoke so much attention from theoretically-oriented commentators. Schoenberg's reply might be read as a manifesto, a gathering together of key points concerning the interface between his compositional world and the double-sided "other" world of music analysis and musical performance, both of which he appeared to regard as problematic and in need of certain checks and controls. This drive for control is shot through the Kolisch letter. As seen above, Schoenberg is quick to correct Kolisch on points of attribution with respect to the tone row as a prelude to voicing his concern that Kolisch has done the analysis in the first place.

It is difficult for performers of Schoenberg's music—who, as a rule, exemplify a particular kind of dedication with respect to a repertoire that generally offers

8 See, for example, John Covach (2000).

few material rewards—to avoid frustration in light of such pronouncements. After all, performers are generally enjoined to make detailed studies of the works they are crafting for performance, going beyond what is actually required to play a work, with a view to uncovering aspects of construction, large-scale phraseology and structure, and historical and critical contexts, all with the aim of enriching their encounter with the work and, one hopes, that of the audience as well.

Navigating the ideological constructions that Schoenberg places around his works requires a great deal of critical acuity. It also calls for new ways of presenting counter-arguments to those constructions through performance, something that is extremely difficult in standard concert set-ups. In this regard, a performer reading the Kolisch letter must understand that the words, while ostensibly addressed to Kolisch, are actually for a wider community in which other composers, critics, and music scholars figure prominently. Furthermore, it is not to his own time that Schoenberg addresses himself: it is to the future. Indeed, Joseph Auner has argued that the sizable and well-ordered legacy that Schoenberg has left, following a life in which teaching, writing, and speaking all played major roles alongside his creative work as an artist, itself forms a kind of "composed public performance." This phenomenon began with his rise to fame and still resonates today in the concert halls and, especially, the institutions of music education and research that seek to understand Schoenberg's complex legacy (see Auner 2005).

An outstanding contemporary example of a performer tackling head-on the issue of how to champion Schoenberg through constructive resistance to his strictures is Daniel Barenboim, who has successfully "performed" music analysis in the public sphere of the concert hall in order to introduce the Variations for Orchestra, op. 31. An account from a British newspaper, *The Independent*, written by the music critic Edward Seckerson for a concert given on 3 February 2010, offers a sense of the potential that, on this occasion, was unlocked by such an approach: "Only Barenboim would then have dared to programme Schoenberg's notoriously 'difficult' Variations for Orchestra Op.31 as the final piece of the series. Nobody left at the interval. Preceding the performance with an 'illustrated talk' that was longer than the piece itself he probably did more for Schoenberg's cause in twenty minutes than others have failed to do in almost a century."

In fact, the ability of the finest performers to work intelligently and artistically to disclose music's most telling ideas is acknowledged by Schoenberg himself, in the Kolisch letter: "I know of course (and never forget) that despite such examinations you never lose sight of what attracted you to this kind of music in the first place: its spiritual, tonal and musical substance" (Schoenberg 1932, 31). He even goes so far as to open a small chink in the armour of his opposition to performers' dabbling in analysis, although he quickly re-emphasises the notion that they should remain concerned primarily with the nuances of their own métier: "For me there can only be an analysis which concentrates on the idea, showing its presentation and development. Of course, one should not overlook artistic refinements in the process" (ibid., 32).

"Performed analyses," as exemplified by Barenboim, Uchida, and Gould, give us important models for carrying out exactly the kind of analysis that Schoenberg states he might tolerate. But these approaches present challenges:

they are multi-faceted, and they subvert the norms of concert-hall behaviour. They require much of the musician, including the breaking down of the phantasmagorical screen between performer and audience.

Through employing types of analysis that centre on tactile aspects, metaphorical reading, and communicative possibilities, performers can feel their way into the rhetoric of the music, and this will have a bearing on their whole process of learning and assimilation. As with any kind of research process, precursor materials can prove useful to this process. After all, they can represent the corresponding process whereby the composer felt his own way into the rhetoric of the new composition.

"PERFORMING" THE ANALYSIS

As an example of how this might work, in the matrix for op. 33a [Fig. 2&3], the most relevant iterations of the row material are highlighted.

	G	7	2	1	11	8	3	5	9	10	4	6
0	B♭	F	C	B	A	F♯	C♯	D♯	G	A♭	D	E
5	D♯	B♭	F	E	D	B	F♯	A♭	C	C♯	G	A
10	A♭	D♯	B♭	A	G	E	B	C♯	F	F♯	C	D
11	A	E	B	B♭	A♭	F	C	D	F♯	G	C♯	D♯
1	B	F♯	C♯	C	B♭	G	D	E	A♭	A	D♯	F
4	D	A	E	D♯	C♯	B♭	F	G	B	C	F♯	A♭
9	G	D	A	A♭	F♯	D♯	B♭	C	E	F	B	C♯
7	F	C	G	F♯	E	C♯	Ab	B♭	D	D♯	A	B
3	C♯	A♭	D♯	D	C	A	E	F♯	B♭	B	F	G
2	C	G	D	C♯	B	A♭	D♯	F	A	B♭	E	F♯
8	F♯	C♯	A♭	G	F	D	A	B	D♯	E	B♭	C
6	E	B	F♯	F	D♯	C	G	A	C♯	D	A♭	B♭

Fig. 2

	0	7	2	1	11	8	3	5	9	10	4	6
0	0	7	2	1	11	8	3	5	9	10	4	6
5	5	0	7	6	4	1	8	10	2	3	9	11
10	10	5	0	11	9	6	1	3	7	8	2	4
11	11	6	1	0	10	8	2	4	8	9	3	5
1	1	8	3	2	0	9	4	6	10	11	5	7
4	4	11	6	5	3	0	7	9	1	2	8	10
9	9	4	11	10	8	5	0	2	6	7	1	3
7	7	2	9	8	6	3	10	0	4	5	11	1
3	3	10	5	4	2	11	6	8	0	1	7	9
2	2	9	4	3	1	10	5	7	11	0	6	8
8	8	3	10	9	7	4	11	1	5	6	0	2
6	6	1	8	7	5	2	9	11	3	4	10	0

Fig. 3

Figure 2. The matrix for op. 33a.

Figure 3. The integer matrix for op. 33a.

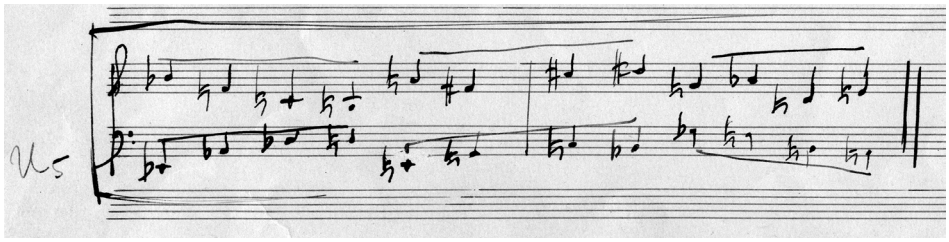

Fig. 4

Playing this row material at the keyboard, one notes the row's particular shape, its descending tetrachords (forming the six opening chords of the piece), which can map onto the material that follows, making a descending hexachord, with the second hexachord composed of rising dyads. The double statement of the material, its distinctive pliability in tetrachordal and hexachordal groups, is important in terms of the construction of the work. But the precursor material shows no evidence of Schoenberg's having constructed matrices similar to these; rather, it appears that he moved straightaway to the process of composition.

The sketch of the row material for op. 33a [Fig. 4] is like a key-code to the entire piece because Schoenberg points up the tetrachords by beaming, the hexachords by a bar line, and the containment of the complete material by boxing it in and using a double bar. The draft conveys a great deal of significant information with respect to the genesis of the work, not least of which is its presentation of two versions of the row material on the bottom left hand side of the page, as P0 and I5, written out in staff notation and placed one atop the other to form contrary motion. This contrary-motion layout, as well as being pleasingly symmetrical to the eye, is correspondingly congenial to play; in piano practice, the physical orientation for contrary motion prompts good form, can serve as a spur to a pianist's spatial awareness, and creates the sense of a "centre" that orients the body.

Just as important as the statement of the prime is what is placed with it—an iteration at I5. This pairing forms the core material for the piece, and it brings us back to our metaphors of "chess played in all directions" and to Schoenberg's idealistic proclamations concerning "a unified musical space with no absolute down, no right or left, forward or backward." But the presentation here is even more significant. The layout demonstrates that Schoenberg's twelve-tone row here is hexachordally combinatorial, so that certain transpositions of the inversion of the row map the first hexachord onto the second; therefore, Schoenberg's gambit allows him to play [composition/chess] in multiple dimensions.[Fig. 5]

P0	0	7	2	1	11	8	3	5	9	10	4	6						
						I5	5	10	3	4	6	9	2	0	8	7	1	11

Fig. 5

These are not merely mental games and processes; they relate to how we can internalise the piece and retain a sense of wonder about the way its construction transforms itself into, and leaves its imprint on, the sound world of the work. So sparing is Schoenberg's use of material that the two row versions and their inversions P0, I5, R0, and RI5 are virtually the only forms used in the work. To show the ramifications of this, one can refer back to the row matrix to show what he did and did not use; the row material for P0 and I5 is shaded in grey, [Fig. 2]

Figure 4. Schoenberg's sketch of PO/I5, op. 33a *erste Niederschrift* (Arnold Schoenberg Center [FS 24]). Used by permission of Belmont Music Publishers.

Figure 5. Linear aggregation of rows, creating double function for intersected material.

My own understanding of the piece actually began through working with this material as sound and, in the process, being drawn to, and fascinated by, four particular bars. These are bars 14–18; and, in the hands of a good performer, they have a distant, lyrical, but near-still quality about them, bookended as they are with bars of disjunct music in a *forte* dynamic. They become like an insert of altered time and affect. This is emphasised further by what Michael Cherlin might have called an "uncanny" (*unheimlich*)[9] recollection of F minor at bar 18. This moves fleetingly through the phrase like a Proustian waft of perfume; recognising the past, the listener reaches out to the gesture, but the sudden cut to "*heftiger, forte martellato*" foils any sustained tonal nostalgia.

So through practice and hearing, the performer learns of the signs that abound, which point to the section from bars 14–18 as being close to the work's centre, or heart—something that is both underlined and reinforced by a sense of abstractness in the sounding phrases. This sense develops because of how the sonorous quality of the lyrical phrases sits alongside disjunct, chordal, and linear structures. This comes to be one of the formal organisational strategies for the piece: the shift between skittishness and lyrical abstraction. In working with the material, one experiences this dialectical approach in the tactile imprint of the music.

The engendering of a centre, or core, in the draft materials for op. 33a becomes even more significant when one considers some of the revelations of music analysis in conjunction with close listening and physical awareness during practice. As noted above, in the sketch of P0 and I5, through the use of a drawn-in bar line that divides his row materials in half, Schoenberg's layout highlights the characteristic of hexachordal combinatorality that he employs so effectively as a structuring principle in the work. Twelve-tone aggregates may be formed by reading "horizontally" across the staffs or "vertically" up and down the two sets of stacked hexachords. In either case, one arrives at a full complement of twelve tones. This property of combinatorality has been written about extensively in the analyses of op. 33a, but its ramifications for performance are also considerable, as one hears when interrogating the material *as* music. [Fig. 6]

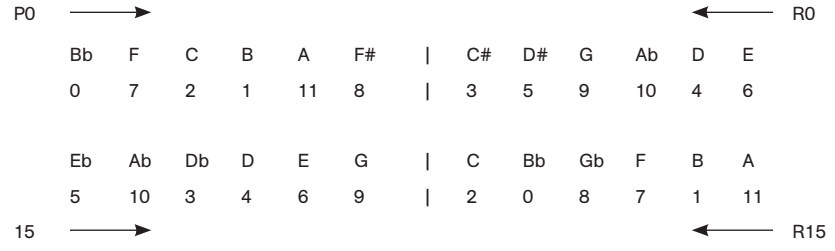

Fig. 6

Figure 6. Principal hexachordally-combinatorial row materials.

9 Cherlin's excellent delineation of *unheimlich* (the uncanny) as a category is found in the chapter "Uncanny Expressions of Time in the Music of Arnold Schoenberg" (Cherlin 2007, 173–229).

Studying a different element of the first draft [FS 24] gives further credence to this view; if we return to a consideration of the material which corresponds to bars 14–18 in the final version, we see that these bars are marked with one of only two instructive affect indications in the entire draft: *cantabile*. The only other written-out term in this stage of the compositional process is its introductory tempo indication *Mäßig*, which appears at the start of the draft as the overall tempo instruction. The marking of *cantabile* is structurally significant, being associated with the majority of combinatorial iterations of P0/I5 until the final eight bars, 32–40, following the "grand pause," in which two P0/I5 iterations occur but without the *cantabile* indication, giving this section an affective distinctiveness that marks it out structurally. The other statements of P0/I5 that lack the indication are bars 10–12 and bars 37–39. These are, in effect, *stretto* bars in which all of Schoenberg's utilised row forms (P0, I5, R0, and RI5) are presented in quick succession—and they can be performed as such, to good effect. They prepare either a sectional shift (bars 10–12) or closure of the work (bars 37–39).

The structural importance of the P0/I5 combinatorial rows is also emphasised through their association with other tempo and affect markings. If, as previously stated, bars 14–18 are emphasised in this reading as structural—and, significantly, as the performative/affective heart of the work—then bars 21–25 underline this through their provision of a mirroring completion that emphasises the central symmetry. Just as the preliminary draft of the work employed contrary motion to highlight mirroring, the statements of P0 and I5 in the bars in question present their hexachords in reverse order. The *cantabile* instruction is maintained, but the affective delineation *ruhiger* is added. [Fig. 7]

A tempo cantabile				*heftiger martellato*		*heftiger martellato*			
P0 Hex 1		P0 Hex 2		R0 (P0 Hex 2,1)		P0 Hex 2		P0 Hex 1	
I5 Hex 1		I5 Hex 2		RI5 (I5 Hex 2,1)		I5 Hex 2		I5 Hex 1	
14–15	$16^{1–2}$	$16^{3–4}$–17	18	19	20	21	22	23	24–25[1]

Fig. 7

The chart in figure 7 shows that this complex of material does indeed form a "heart" for the work, with the four-bar hexachordally combinatorial "cantabile" sections enclosing a section marked "heftiger martellato," in which the row forms R0/RI5 allow overlapping linear aggregates to form both with the material that precedes and with that which follows. But this central section has other points of interest as well. In his article on the relationship between Schoenberg's row tables and the musical idea, or *Gedanke*, Joseph Auner notes the point made above that within Schoenberg's sketch [FS 24] there is no full matrix evident for op. 33a and that, instead, Schoenberg started the compositional process first, composing only materials that related to P0 and I5 (Auner 2010, in particular 171). However, Auner makes the additional observation that mid-way through the sketch, Schoenberg appears to have become "stuck." At this point, he interrupts the musical content of the text to return to devise row materials for P2 and I7 and also P7 and I0. These correspond to materials used in a fragmentary way within bars 28–31 of the work. This way of working with the row material in

Figure 7. Structural chart for op. 33a, bars 14–25.

"real time" has some resemblance to how one might practise a piece of music; its potential sense of co-creativity can be helpful for performers, engendering a closer sense of identity with the compositional process. It underlines the conclusion that if, in the manner of Gould and Uchida, one can have as full as possible an intellectual, emotional, and kinetic understanding of the material even before learning the work, the potential for some other kind of deeper content emerging within the culminating performance of the music is enhanced.

Thus the sound quality of the material in practice leads one to a performative reading in which the sonorous qualities of the combined linear/vertical fields become a central concern. It therefore leads to a rather different reading than one might derive from a purely score-based approach. I find that experiments with different opening "gambits," one of which I shall describe below, have the effect not only of unfolding each iteration of the piece as a new entity but also of revealing it as variations in a state of flux, both highly coherent and fleeting. I hear and play the variant materials as gravitating toward a coherent sonorous core, which itself is derived from Schoenberg's opening gambit, the iteration of the P0 and I5 forms in tetrachordal stacks.

Performance Choices: Gambits, Experiments, and "Grasping at the Unknown"

A gambit is a chess opening in which a player, most often "white," sacrifices material, usually a pawn, with the hope of achieving an advantageous position. In performances, we do make sacrifices; performances are not ideal presentations, but a series of negotiations. So there are benefits in linking how a work is experienced through the understanding of the physicality of the performer with newly considered historical evidence that considers performers as real people, with real, embodied experiences of the music. Performers thus become agents able to make both good and bad choices and able to respond variably to the outcomes of these.

The opening of op. 33a, conceived as a gambit, might involve different "moves" with the opening six chords that serve as the "motto" for the whole work. The chords appear disjunct—but are they? If so, what about the over-arching phrase mark? The standard performance approach here is noted in Jean-Jacques Dünki's (2006, 114) book on performing Schoenberg's piano music,[10] in which he suggests a fingering approach to bring out the top line of the chords. Dünki rightly points to the difficulty of sustaining a melodic line in which the swapping of hands also alternately allocates that top voice to the left and right hands. Maintaining the consistency of the line indeed becomes a problem that must be addressed in practice. Once this is achieved, the maintenance of a true, overlapping legato, beyond that which may be achieved by strategic use of the

10 Dünki's approach in this book is determinedly pragmatic; he makes extensive reference to Schoenberg's sketches and writings, but reads them rapidly back into the process of generating performances. Indeed, the book is accompanied by Dünki's own CD recording of Schoenberg's piano works, performed on what might be regarded as a "period" instrument, Schoenberg's 1912 Ibach piano. Dünki carries out his research with a view to engaging not in the development of abstract ideas but rather in the development of well-informed performances.

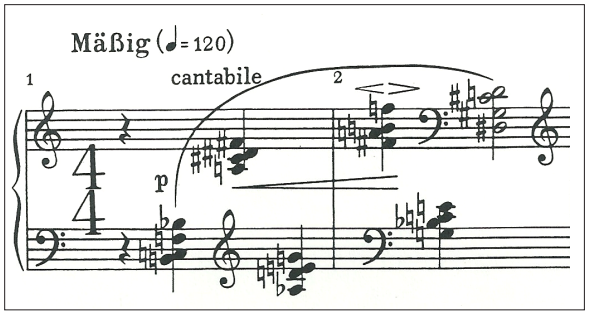

Fig 8.

right pedal, is also a concern, as is the creation of an appropriate sound-world based on good balancing of the chords. But the emphasis on the top voice alone is not the only option open to the pianist. [Fig.8]

Another performer's gambit might be for the pianist to "play down" the standard "top-voicing" (B♭, F♯,G, F, E, D = 0, 8, 9, 7, 6, 4) and to seek out instead the conjunct internal voices that link the chords (B♭, A, A♭, F♯, E, D = 0, 11, 10 [semitone series], 8, 6, 4 [tone series]). This second approach is of interest because it creates a motivic link with the section beginning in bar 14, which I proposed earlier as introducing the core of the work, by using this three-note tone/semitone motivic series. A fusion of these approaches might be the best approach of all, linking the "cantabile" indicated to the conjunct inner movement of motivically coherent material. This is a rather "Gouldian" tactic, and it becomes part of what we might call "informed artistic experimentation." In a sense, it solves the apparent contradiction of the long phrase, since the legato that melds the phrase together exists in the inner voices, alongside the disjointed upper melodic material. It also provides a viable approach for the entire piece, since these linear-versus-disjunct complexes, and transpositions of them, appear throughout the work.

The point of all of this is that experimental approaches can yield a possible response to Schoenberg's dismissal of the usefulness of identifying a row—a response that neither accepts it nor refutes it. It may indeed be true that a level of understanding that stops with solving the row puzzle gets us nowhere particularly useful. At the same time, an experimental approach necessitates more knowledge, not less, since the experimental system is full of choices and narratives:

> The retrospective view of the scientist [or artist-researcher] as a spontaneous historian is not only concealing but in many respects also revealing. It reminds us that an experimental system is full of stories, of which the experimenter at any given moment is trying to tell only one. Experimental systems not only contain submerged narratives, the story of the repressions and displacements of their epistemic concerns; nor, as long as they remain research systems, have they played out their potential excess. Experimental systems contain remnants of older narratives as well as shreds and traces of narratives that have not yet been related. Grasping at the unknown is a process of tinkering. (Rheinberger 1997, 185–186)

Identifying the row is thus the beginning of the journey and of the tracing of its "story." It is neither the journey's terminus nor its epilogue; and far from meaning that the work's problems are "solved," it opens up a whole vista of freshly problematised terrain for exploration. In this kind of game, a sense of performer autonomy can create new musical forms even within "works" in which the compositional form may seem set or obvious.

Figure 8. Bars 1–2 *Klavierstück* op. 33a. © 1929, 1956 by Universal Edition A.G., Wien/UE 9773.

The Kolisch letter discussed in detail above demonstrates Schoenberg's determination to cement his historical position (and, in the process, betrays his insecurity about how effective his measures will be), as well as driving home the underlying message that performance is part of his legacy—even though his manner of communicating with performers conveys a distinct sense that their positions in the creative hierarchy are inferior to his own. This leads to a series of paradoxes: "I am convinced that for a composer who knows nothing whatever about using rows there is a stimulus in learning how he can proceed, a purely technical hint as to the row's potentialities. But aesthetic qualities are not disclosed in this way, or only incidentally" (Schoenberg 1932, 31). This is one of the most problematic utterances of the letter. For performers, the separation of the row material from aesthetic qualities of the music simply does not ring true; the qualities of a row, its intervallic contours, whether conjunct or disjunct, the extent to which the row has sonoral resonances of tonal music in its structures (as in the prevalent triadic echoes of Alban Berg's tone-row arrays), the use of rows that have particular mathematical/intervallic qualities (such as the all-interval "Klein row")—all these contribute to the performer's aural and tactile relationship to the music. Furthermore, the mathematical aspects of row structures and their utilisation that analysis can reveal, and their relationship to musical structure (as in hexachordal combinatorality or the prevalent use of "mirroring and canons," for example), far from draining a work of its "poetry," can generate an intensified sense of wonder for the performer of the work.

So, for a performer, it is not possible to accept at face value what Schoenberg has written in his letter. Instead, it might be instructive to remember his earlier reflections upon being asked for titles for his Five Orchestral Pieces, op. 16. In a diary entry of 27 January 1912, Schoenberg writes: "The wonderful thing about music is that one can tell all, so that the educated listener understands it all, and yet one has not given away one's secrets, the things that one doesn't admit, even to oneself" (quoted in Reich 1971, 51). Again, the statement is paradoxical, in the mutual exclusivity of "telling all," yet "not giving away one's secrets." But the core of the matter is in the medium within which the "telling" takes place: it is within the musical *idea* that Schoenberg "tells all," something that articulation in written language (in this case, titles for movements in op. 16) cannot capture, both despite and *because* of its literal nature. For Schoenberg, his "truths" can hide in plain sight while communicating their messages tacitly. Far from being a modernist sentiment about the refractory nature of artistic truth, this is a reminiscence of aspects of romanticism, epitomised by the Friedrich Schlegel quotation that precedes Robert Schumann's *Fantasie* op. 17:

> Durch alle Töne tönet
> Im bunten Erdentraum
> Ein leiser Ton gezogen
> Für den, der heimlich lauschet.[11]

11 "Resounding through all the notes / In the earth's colourful dream / There sounds a faint long-drawn note / For the one who listens secretly"; this forms the motto for Robert Schumann's *Fantasie* op. 17 (Schumann 2003).

This is an appeal to the initiated, to those who listen with a secret insight and sensitivity; Schoenberg preserves similar—and by now somewhat anachronistic—notions in aspects of his own thinking concerning communication, in keeping with his wish (and his careful construction) to be seen as an inheritor of the grand Austro/German musical tradition, something that also included his role as a teacher. The sense of obedience to the master that bound Schoenberg and his composition pupils together has had resonances in the performance history of his works, even long after his death. In part, this can be accounted for by the fact that many early performers of his works were also his pupils and/or friends. One might conclude that these performers adhered very literally to Schoenberg's words to Kolisch. But that was not always the case, as the example of Edward Steuermann demonstrates. His reflections on the topic of music analysis, coming as they do from the standpoint of a pianist who studied composition with Schoenberg, are worth noting at length:

> Analysis is a procedure for comprehending single features of the movement of tones we call music in order to get a better picture of their coherence. Primarily analysis is applied to music we feel instinctively, music we "understand." "Understanding" is not necessarily increased by analysis; successful analysis is rather the consequence of understanding. Nevertheless, assuming there is no such thing as complete lack of understanding of a masterwork, we can analyze in order to "understand" better, to get out of a chaotic condition of mind and into an organic and positive following of the events—to agree with them. Only somebody completely unmusical could lack absolutely the ability to follow, at least partially, the flow of the music (in saying this I do not rule out a sense of bewilderment, of contradiction, of lack of continuity, an inability to feel the work as a whole). "Not to understand" means in effect not to trust the composer; one might be right—sometimes. But to understand means always to love—and finally to agree completely and find in one's heart the image of the music projected by the composer.
>
> If this situation has not yet been reached, analysis may be tried as a guide, though in order to be able to analyze one must be able to feel the basic coherence of the events, in some detail at least, later in complexity. (Steuermann 1989, 131)

On the one hand, Steuermann's comments suggest that there can be no final and successful analysis other than that which leads to complete agreement with the composer's image of the music. They also link understanding with love—but in a way that implies something closer to unconditional surrender to the composer's vision. At the same time, Steuermann suggests that the roots of analytical understanding reside in the analyst's own a priori capacity to "feel"—or, perhaps, to understand in a pre-intellectual way—how the music works. The performer might initially take encouragement from this appeal to the "instinctive" dimension of understanding as the precursor of the journey to find the heart of the music. However, the idea that all exploratory roads—or at least those with any validity—must ultimately lead back to the composer's undisputed supremacy makes it more questionable whether, for the performer, the journey through the territory of analysis is likely to lead anywhere that offers genuine revelations.

PERFORMING SCHOENBERG NOW

For today's performers, the very disjunction between the perceptual frames of music analysis and performance, together with the fact that Schoenberg can no longer intervene personally in mediating between the two, makes the situation more open and ambiguous. An analytically aware performance of a work may indeed be one that "transgresses" Schoenberg's strictures; nevertheless, in the right hands it might serve the genuinely useful purpose of facilitating a contemporary audience's understanding of the work in terms that they and the performer have in common. Arguing against Schoenberg's injunction to Kolisch that performers gain little that is genuinely useful by identifying a composition's twelve-tone "signature" at the most literal level, we may counter that the analytical matrix is about much more than analysis; in it, we can find the interrelationships that *make* the tone colours that we hear. Moreover, and this is especially true of twelve-tone pieces written for piano solo (where the instrument of the final performance is often also the sonorous tool of the compositional process), we can project ourselves, to some extent, into the web of interrelationships and tone colours that would have been inhabited by the composer in the very act of creation.

As I have tried to show, in wielding this understanding, we can play both "with" the material and "against" it. Today's performers need to take a robust, and sometimes combative, view of Schoenberg's writings, especially those that pertain to performance. Like adversaries in a chess game, they need to engage tactically with his utterances, aware that these were a means by which he sought to gain mastery over his legacy by marshalling all of the elements at his disposal but also conscious that each "move" he made can be interrogated for what it reveals of his overall strategy. Without two players, the game is void; moreover, both players need to strive to inhabit not only their own tactical mind-set but also that of their opponent/co-participant.

I believe that discussion of Schoenberg's music in the manner that I have attempted here, although based on existing theory, reveals profound opportunities to use artistic research approaches in novel ways precisely *because* discussion of the composer has elsewhere been so heavily co-opted by traditional forms of study that do not involve musical practice at all. Where the hegemony of Schoenberg's works and statements is played out entirely in the theoretical realm, contesting it can only be achieved by pointing out internal inconsistencies and contradictions that operate on the rational plane. Artistic experimentation offers an additional dimension in which consistency may be tested by bringing into play issues of what "feels" right, both physiologically and affectively.

REFERENCES

Arnold Schoenberg Center. 2007. "Mitsuko Uchida on Schoenberg's Piano Concerto." YouTube video, 8:36. Accessed 19 May 2013. http://www.youtube.com/watch?v=PmWRttC07lo.

Auner, Joseph. 2005. "Composing on Stage: Schoenberg and the Creative Process as Public Performance." *19th-Century Music* 29 (1): 64–93.

———. 2010. "Schoenberg's Row Tables: Temporality and the Idea." In Shaw and Auner 2010, 157–76.

Bujic, Bojan. 2010. *Arnold Schoenberg*. London: Phaidon.

Cherlin, Michael. 2007. *Schoenberg's Musical Imagination*. Cambridge: Cambridge University Press.

Covach, John. 2000. "Schoenberg's 'Poetics of Music,' the Twelve-Tone Method, and the Musical Idea." In *Schoenberg and Words: The Modernist Years*, edited by Charlotte M. Cross and Russell A. Berman, 309–46. New York: Garland.

Davies, Robertson. (1972) 1983. *The Manticore*. In *The Deptford Trilogy*. London: Penguin.

Djerassi, Carl. 2008. *Four Jews on Parnassus: A Conversation: Benjamin, Adorno, Scholem, Schönberg*. New York: Columbia University Press.

Dünki, Jean-Jacques. 2006. *Schönbergs Zeichen: Wege zur Interpretation seiner Klaviermusik*. Vienna: Lafite.

Ehn, Michael, and Ernst Strouhal. 2004. "Play Schönberg 2: Trial Game of Arnold Schönberg's 'Coalition Chess.'" In Meyer 2004, 78–80.

Hoagland, Mahlon B. 1990. *Toward the Habit of Truth: A Life in Science*. New: York: W. W. Norton.

Knorr Cetina, Karin. 2001. "Objectual Practice." In *The Practice Turn in Contemporary Theory*, edited by Theodore R. Schatzki, Karin Knorr Cetina, and Eike von Savigny, 175–88. London: Routledge.

Meyer, Christian, ed. 2004. *Arnold Schönberg: Games, Constructions, Bricolages*. Vienna: Arnold Schoenberg Center.

———, ed. 2006. *Arnold Schoenberg's Brilliant Moves: Dodecaphony and Game Constructions*. Vienna: Arnold Schoenberg Center.

Reich, Willi. 1971. *Schoenberg: A Critical Biography*. Translated by Leo Black. London: Longman.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

Schoenberg, Arnold. 1932. Letter from Arnold Schoenberg to Rudolf Kolisch, Berlin, 27 July. In *Schoenberg, Berg, Webern: The String Quartets; A Documentary Study*, edited by Ursula von Rauchhaupt, 31–32. Hamburg: Deutsche Grammophon Gesellschaft.

———. 1941. "Composition with Twelve Tones (1)." In *Style and Idea: Selected Writings*, edited by Leonard Stein, translated by Leo Black, 1975, 214–44. London: Faber and Faber.

Schumann, Robert. 2003. *Fantasie C-dur op. 17*. Edited by Ernst Herttrich, fingering by Hans-Martin Theopold. Munich: G. Henle Verlag.

Seckerson, Edward. 2010. Review of concert performance by Staatskapelle Berlin and Daniel Barenboim (conductor), Royal Festival Hall, London. *The Independent*, 3 February. Accessed 11 May 2013. http://www.independent.co.uk/arts-entertainment/classical/reviews/staatskapelle-berlin-barenboim-royal-festival-hall-london-1888208.html.

Shaw, Jennifer, and Joseph Auner, eds. 2010. *The Cambridge Companion to Schoenberg*. Cambridge: Cambridge University Press.

Shawn, Allen. 2002. "Silence, Order, and Terror 1914–1933." Chapters 15–20 in *Arnold Schoenberg's Journey*, 171–234. New York: Farrar, Straus and Giroux.

Steuermann, Edward. 1989. *The Not Quite Innocent Bystander*. Edited by Clara Steuermann, David Porter, and Gunther Schuller. Translations by Richard Cantwell and Charles Messner. Lincoln: University of Nebraska Press.

Zaman, Daniel, and Ernst Strouhal. 2004. "Play Schönberg 1: Redaction of Arnold Schönberg's 'Coalition Chess.'" In Meyer 2004, 73–77.

Zweig, Stefan. 2006. *Chess*. Translated by Anthea Bell. London: Penguin.

Research Organs as Experimental Systems

Constructivist Notions of Experimentation in Artistic Research

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INSTRUMENTS OF KNOWLEDGE

The interior of Örgryte New Church in Gothenburg, Sweden, is dominated by the richly ornamented symmetrical facade of the North German Baroque Organ that was inaugurated in 2000. The instrument is a replica of the case of the 1699 Schnitger organ in the Lübeck Dom and surviving pipework in the Schnitger organ in the Hamburg St. Jacobi church. It was built by GOArt, the organ research centre of the University of Gothenburg. I visited the church and the organ in December 2010. My guide was Joel Speerstra, researcher at GOArt and the editor of a volume containing extensive documentation of the designing and building of the organ (Speerstra 2003b). When we came to the console, consisting of four manual keyboards and one pedal keyboard, one of the researchers of GOArt was studying the organ to learn about the qualities of its key action. This mechanism transfers the movement of pressing a key from the keyboard to the wind chest, a large wooden box on which the pipes sit, where it opens a valve. As a result, wind flows into all the pipes for which the stops have been pulled, thus producing a tone.

The researcher was sitting behind the keyboard of a laptop. Wires attached the computer to a mechanical device that hovered over one of the organ keys. [Fig. 1] Upon receiving a cue from the computer, the device pressed the organ key. It then measured the speed and force of the movement in relation to the counterforce of the organ's key action. The resulting stream of data was fed into the computer and analysed, rendering intricate diagrams of the small forces that were transferred inside the enormous organ case. The goal of the researcher was to analyse the attack point of several stops, the exact moment that a pipe

Fig. 1

begins to speak when a key is pressed.[1] Organ players use the attack point to articulate the organ sound and, as such, it is an essential element in organ playing. The situation had all the elements of a laboratory setting. There was an object of investigation that was manipulated in a controlled way in order to generate data. These were interpreted against a background of expected outcomes and theories. The mechanical finger turned the church into a research lab. Using the device, the researcher was able to quantify and visualise knowledge that is normally seen as embodied and implicit.

Church organs have always been instruments of knowledge. These sometimes ancient instruments can be compared to coral reefs, containing the material, scientific, and artistic sediments of ages. Old organs that have survived to the present day often have been changed in many ways. Pipes have been removed, renewed, or retuned. An electric blower has replaced the person who once trod the bellows by foot. The mechanical action of the keyboard, the stops, and the sliders in the wind chests have been changed. New pipes and parts have been added. All these carry information about how the instruments were designed and built, how they were meant to sound, and how they formed part of musical practices, both secular and religious. As Snyder (2002a, 1) puts it, organs are both a historical and an aesthetic mirror that have "stories to tell about the times in which they were built that go far beyond the music that was played on them."

One way of learning more about these stories is studying and restoring existing instruments. In recent decades, however, building replicas of historical

1 An organ usually has many stops, grouped in different "families" of pipes that render different sounds, such as Reeds, Principals, Flutes, and Strings.

Figure 1. Measuring the key action at the research organ built by GOArt in Gothenburg. Photograph taken by the author.

musical instruments has become an important strand in both musical performance practice and organology (Bijsterveld and Peters 2010).[2] In the case of church organs, a special category of these replicas are called "research organs," and these are at the centre of large research projects that cover a broad range of disciplines. Since the North German Baroque Organ in Gothenburg was inaugurated, research organs have been built by GOArt at the Eastman School of Music of Rochester University and at the College of Arts and Sciences of Cornell University. In a video about the organ at Cornell University, Anette Schwarz, chair of the Department of German Studies, reflects on the value of a research organ: "This is very rare, that you can... find an object that allows you to ask historical, sociological, literary, theological, and scientific questions" (Cornell University College of Arts and Sciences 2010, 0:44).

In this article, I analyse research organs such as the North German Baroque Organ in Gothenburg as experimental systems (Rheinberger 1997). Rheinberger defines these systems as "[basic units] of experimental activity combining local, technical, instrumental, institutional, social, and epistemic aspects" (ibid., 238). Rheinberger's work can be situated in the field of science and technology studies (STS). In her foreword to the *Routledge Companion to Artistic Research*, Helga Nowotny (2010) strongly argues for the relevance of STS in describing and analysing the new knowledge practices that emerge under the heading of artistic research. I agree with Nowotny that STS offers a rich set of concepts, studies, and insights that may inform reflection on some of the core issues in the emerging field of artistic research. The questions I want to answer in this paper are how research organs can be conceived as experimental settings and how this helps to better understand the projects of STS and artistic research. How can we develop the notion of "experimentation" as common ground between STS and artistic research?

To answer that question, I will first highlight some of the central insights from STS by going back to a seminal contribution to science studies and the history of scientific experiments, *Leviathan and the Air-Pump*, by the historians of science Steven Shapin and Simon Schaffer (1985). If the church organ in its simplest anatomy can be considered to be an air pump that has the creation of art as a goal, the air pump that Robert Boyle constructed in 1658–59 was meant to experimentally create the matters of fact that were to found proper knowledge. I will then focus on some aspects of the building of the research organ in Gothenburg and how they can be interpreted from an STS perspective. Finally, I will mobilise the vocabulary of Rheinberger to explore the experimental situation that a research organ can offer.

2 This approach is summarised by Harald Vogel (2003, 345), a German organist and organ scholar who was active in the Swedish GOArt project: "Building new instruments in historical styles is a path that we must take in the future. There are two reasons why we cannot take our antique instruments closer to their original state than they are now. The first is that there are additions to the original material that we cannot take away. The second is that, in restorations, we have not gone far enough in many respects. I think, therefore, that the Göteborg project is a turning point in the history of restoration and replica in Europe: ideally, restoration should always be related to a replica."

THE AIR-PUMP REVISITED

Leviathan and the Air-Pump (1985) analyses the controversy between Robert Boyle and Thomas Hobbes about the value of experiments as an acceptable method to produce knowledge. For Robert Boyle, his experiments with the air-pump in the 1660s generated "matters of fact," authenticated experimental knowledge that had a probabilistic nature and that could thus be separated from universal theory (Shapin and Schaffer 1985, 39). Hobbes argued that knowledge could only be founded on logic and geometry, as these could be considered as absolute certainties. Notwithstanding the complexity of their overall argument, as Shapin and Schaffer reconstruct it, the crucial difference between Boyle and Hobbes comes down to the role of assent and agreement on matters of fact. In Boyle's view, knowledge claims did not need to be universal, but on the contrary were subject to debate and dissent. Knowledge production thus became a process that, according to Shapin and Schaffer, rested on three technologies: "a *material technology* embedded in the construction and operation of the air-pump; a *literary technology* by means of which the phenomena produced by the pump were made known to those who were not direct witnesses; and a *social technology* that incorporated the conventions experimental philosophers should use in dealing with each other and considering knowledge-claims" (ibid., 25). For Hobbes, who rejected the possibility of a vacuum, it was precisely the dissensus that came with the experimental method that threatened political stability and universal order, which might eventually lead to civil war.

Shapin and Schaffer (ibid., 15) state that their book is "an exercise in the sociology of scientific knowledge." In the 1970s scholars of SSK started to study the development of a scientific field and the success of knowledge claims not from the internal cognitive structure of an argument or experiment but from external social and historical circumstances. Central in their strategy was the principle of symmetry: truth and error in scientific explanations and theories should be analysed in the same way. It is only with hindsight that we can determine which ideas and theories have turned out to be correct. This hindsight knowledge should not be projected into the past. In reconstructing the debate over Boyle's experiments with the air-pump, Shapin and Schaffer were careful to apply this principle of symmetry and avoid the kind of "whig" history that according to them was common in science history at the time they wrote their book. Instead, they developed a "stranger's perspective" (1985, 18) and argued that the ideas of both Boyle and Hobbes were respected in the 1660s. To understand the two methods of knowledge production, both should be studied on the same terms, taking into account not only ideas and experimental procedures but also social factors such as the instability of English Restoration society after the 1660s.

In an essay-review of *Leviathan and the Air-Pump*, the philosopher and anthropologist of science Bruno Latour (1990) argued that the importance of the book was not that it applied the SSK principle of symmetry to a historical case study. Where SSK scholars would explain the work of Boyle and Hobbes in terms of their social context, Shapin and Schaffer showed a second principle of symmetry. Instead of explaining the construction of matters of fact from the

social context in which they emerged, Latour argued in his review, they made it clear that the whole idea of social context should be abolished. In his view, the book gave evidence for the claim that the distinction between Nature and Society, itself a product of modernity, is entirely untenable because the natural and the social are coproduced.[3]

This second symmetry meant that an analysis of an experimental situation should include the material apparatus that was set up, and this is what Shapin and Schaffer did in their account. They gave centre stage to the technology of the air-pump. "The matters of fact that constituted the foundations of the new science were brought into being by a purpose-built scientific machine" (Shapin and Schaffer 1985, 26). And it was this machine that became an object of dissensus. According to Hobbes, that the machine might leak and thus render false data proved that the experimental method failed. Next to that, the sheer difficulty of building a machine that would stand up to the test meant that many people could not witness the experiment. Most would have to be convinced not by material techniques but by the literary techniques of reporting the experiments. The mechanical device could only do its work within the specific society in which its data were to be discussed. And vice versa, society was transformed as the knowledge travelled from Boyle's laboratory to other places, Latour argued.[4]

STS scholars study the work that scientists do to create matters of fact. For these facts to become true, the world in which they become true has to be adjusted to them. A famous example of this line of argument is Latour's own analysis, in *The Pasteurization of France* (1988), of Pasteur's discovery of penicillin. Contrary to common wisdom, Latour argues that facts are not true irrespective of where they are. On the contrary, they can only become true in worlds constructed precisely to reveal their truth. Penicillin could only become a proper and effective cure if, in addition to organising the laboratory in which Pasteur worked in such a way that it could reveal its properties, the world of farmers and cows was made to resemble that laboratory to such an extent that there too penicillin "worked." To put it differently: facts are like trains. They cannot move through the world without the infrastructure of railways, tickets, stations, conductors, et cetera. Looking at science-in-the-making thus involves not only ignoring the outcome of all the work, ignoring the possibility that

3 For an elaboration of this argument, which is at the heart of Latour's anthropology of science, see Latour (1991).

4 "The triumph of Boyle is to transform a bricolage around a patched up air pump into a decisive way to win the partial assent of gentlemen about matters of fact; the triumph of S & S is to explain how and why discussions about the Body Politic, God and His miracles, Matter and its power, could be made to go through the air pump. This mystery is never explained by the social contextualists of science. They take for granted that there is a social macro context—England, Dynasties, Capitalism, Revolution, Merchants, Church—and that this context somehow influences, shapes, reflects, reverberates, presses upon 'ideas about' matter, elasticity of air, vacuum, and Torricelli tubes. But they never account in the first place for the establishment of a link between God, King, Parliament and a suffocating bird in the closed transparent container of a pump the air of which is sucked out by the crank manned by a technician. Why is it that the experiment on the bird translates all the other disputes, and does it in such a way that those who control the pump also control the King, God, and their retinues of macro-factors?" (Latour 1990, 152–53).

differences between social and non-social factors play a role, but also ignoring the seemingly self-evident boundaries scientists erect to differentiate their scientific work from the rest of the world.

This line of reasoning suggests a third principle of symmetry that can be deduced from the work of STS scholars. We should ignore the seemingly self-evident boundaries between artistic practices and other practices in exactly the same way as we ignore the boundaries between science and the world. This third symmetry is only hinted at in Shapin and Schaffer's book. To make their point of the importance of a "stranger's perspective," they refer to Svetlana Alpers's book *The Art of Describing* (1983), in which she compares Dutch descriptive landscape painting to English empiricist science. Both the artist and the experimentalist were to imitate the act of unmediated seeing in their representations. "With the acceptance of this convention for knowledge, and with the execution of the craft of representation, the artful nature of making representations disappears, and they acquire the status of mirrors of reality. Our project, therefore, is the same as Alpers': to display the conventions and the craft" (Shapin and Schaffer 1985, 18). Now one could argue that the close connections between scientific and artistic practices are typical only for the seventeenth century and cannot be generalised as a principle of symmetry.[5] This misses the methodological point that both Shapin and Schaffer and Bruno Latour make. An STS approach entails ignoring the definitions, boundaries, and differentiations that science itself uses to produce matters of fact. Recently, STS researchers have studied various boundary crossings between science and other neighbouring disciplines as well as studying different aspects of artistic practice.[6] In such studies of artistic practice, a similar approach is taken to that in science. Like the departure from science's self-understandings, STS opposes itself to art's focus on notions such as originality, autonomy, and creativity as relevant causal explanations. Thus, there would not be an a priori distinction between scientific facts and works of art.

What does it mean to apply the three constructivist principles of symmetry—truth and error, nature and society, science and art—to the question of how research organs can be conceived of as experimental settings, and how does this help us better understand the projects of both STS and artistic research? To answer these questions, I will focus on two aspects of the building of the North German Baroque Organ in Gothenburg: its wind system and its pipes.

MEASURING WIND, CASTING PIPES

The North German Organ Research Project at the University of Gothenburg aimed at building a copy of the 1699 Schnitger organ in the Lübeck Dom, which was destroyed during a bombing raid in 1942 and of which only some

5 For a recent study on art and science in the early modern Netherlands, see Jorink and Rademakers (2011).

6 For research on boundary crossing that is relevant here, see, for instance, Star and Griesemer (1989); Galison (1987). For examples of STS research in the arts, see Gomart and Hennion (1999); van Saaze (2009); Yaneva (2003).

photographs remain.[7] In its time, it was a famous organ. Johann Sebastian Bach travelled on foot all the way to Lübeck from Thüringen, near Weimar, to hear this organ and Dietrich Buxtehude, who was organist at the St. Marien church in Lübeck, also must have played on the organ in the Dom. The scholars and craftsmen in the project, which started in the early 1990s and was financed by the Swedish government and the European Union, among others, built the new organ in the Örgryte church, one of the larger churches in Gothenburg.

The aim of the project was to gain the knowledge and experience necessary to construct in a Swedish church an organ the way it might have been built by Arp Schnitger in the late seventeenth century in Northern Germany. The new pipework made in the project is a research copy of the surviving pipework in the Schnitger organ in the Hamburg St. Jacobi church. This organ had a facade with long thirty-two-foot pipes that would not have fit in the church in Örgryte. The Lübeck Dom organ case was chosen because it was the right size for the church in Sweden. Using the old pipework from the Hamburg organ as the main study material for the new organ, the ambition was to come as close as possible to the "language" of Schnitger: "So, using the most coherent collection of pipework to survive from any Schnitger organ, we tried to learn about the craft processes that produced the original object, in order to *perform* them well enough to build a new object in the same language as the original" (Speerstra 2003a, 18–19). This quote is taken from a four-hundred-page edited volume written by many authors, all of whom were involved in the project.[8] The volume offers a detailed documentation of the ten-year process. First, it describes how the dimensions of the new organ were deduced from the three remaining photographs of the organ in the Lübeck Dom by analysing features including the position of the photographer, the distance to the organ facade, and the relative angles. It continues by documenting the construction of the organ case and the carvings, both made from Swiss oak. Much attention is paid to documenting the construction of the wind system and the pipes. Computer simulations and full-scale-model experiments were done to understand the wind flows in the wind supply system, from the bellows to the pipe feet. A method was reconstructed for casting the metal for the organ pipes on sand according to seventeenth-century practice.

The production of the organ sound is a highly complex process in which wind pressure is one of the critical parameters. The pressure at the pipe foot is the result of the wind system's response to the activities of the organ player and is, by nature, very unsteady. Changing flows create pressure waves that are spread through the wind system, interact with other waves, and are reflected at the system boundaries. The research necessary to understand these complex flows inside the organ's wind system was carried out at the Department of Thermo and Fluid Dynamics at Chalmers University of Technology in Gothenburg. A full-scale model of a wind system according to North German Baroque practice

7 The case study in this article has also been analysed in two previous articles. See Peters (2009); Bijsterveld and Peters (2010).

8 See also Snyder (2002b).

was placed in the laboratory to measure wind flows inside trunks, bellows, and valves according to Schnitger prototypes and thus to build a complete data model of the North German Baroque organ's wind system. Next to this, computer models were used to simulate wind flows. Measurements and computer simulations could thus be compared.

Because the organ builders were finally unable to say with certainty which type of wind system Schnitger chose, they came up with an ingenious solution. Instead of building one wind system for the new organ, they added extra channels and extra valves to the system to emulate three documented wind systems from Schnitger systems in Hamburg, Magdeburg, and Zwolle, where twelve wedge bellows have been preserved. These bellows in turn served as a model for the bellows of the organ in the Örgryte church.

In parallel with the reconstruction of the wind system the researchers worked on the second crucial element in the production of organ sound, the organ pipes. A central question was why pipes from the seventeenth century sound so different, and according to many organ players and builders also better, than new pipes that had the same shape and construction.[9] To answer that question, the metal composition of preserved seventeenth-century pipes was analysed. "The metal consisted not only of tin and lead, but also of impurities and trace elements, small levels of bismuth, antimony, copper, silver, and arsenic. These trace elements affect the hardness of the metal, the casting methods, and the workability of the metal" (Carlsson et al. 2000, 39). When the alloys for the pipes had been determined, the next step was to relearn the seventeenth-century practice of casting the metal sheets that are the raw material from which the pipes are made. The casting starts with pouring the melt, basically a lead-tin alloy, into a wooden casting box that has an opening at the bottom. The casting box is placed on a long and narrow table, the casting bench. When the casting box is pulled along the bench from one end to the other, the melt will run out and spread into a thin layer covering the bench. The melt cools down and solidifies into a metal sheet.[Fig. 2] "If the casting bench is moved at a constant speed, the metal sheet thins out toward the end, a characteristic that the 17th century organ builder calculated. Historic pipes are often thinner at the top, and therefore weigh less at the top than at the bottom, giving better stability and simultaneously a better resonance in sound" (Carlsson et al. 2000, 41).

In modern organ-building traditions, the casting bench is made of stone or wood and is covered with a cloth. In some earlier traditions, however, the casting bench was a fairly deep box filled with fine sand. An important question was whether the material properties of the pipe metal depended on the use

9 Munetaka Yokota (2003, 165), who was responsible for the making of the pipes for the new organ in the Örgryte church, defines this historic sound as follows: "These old pipes have a beautiful balance between 'musical' sound and 'noise,' as well as a good sense of balance between the strength, length, and character of the speech and the sustaining tone … Was the old sound partly a product of the aging of the materials, or could we reach this level of quality again in a modern instrument? Essentially I define 'good sound' as sound that has a sense of life. The listener senses the life from the sound of each pipe, each stop, and several stops together interacting symbiotically just like in human society."

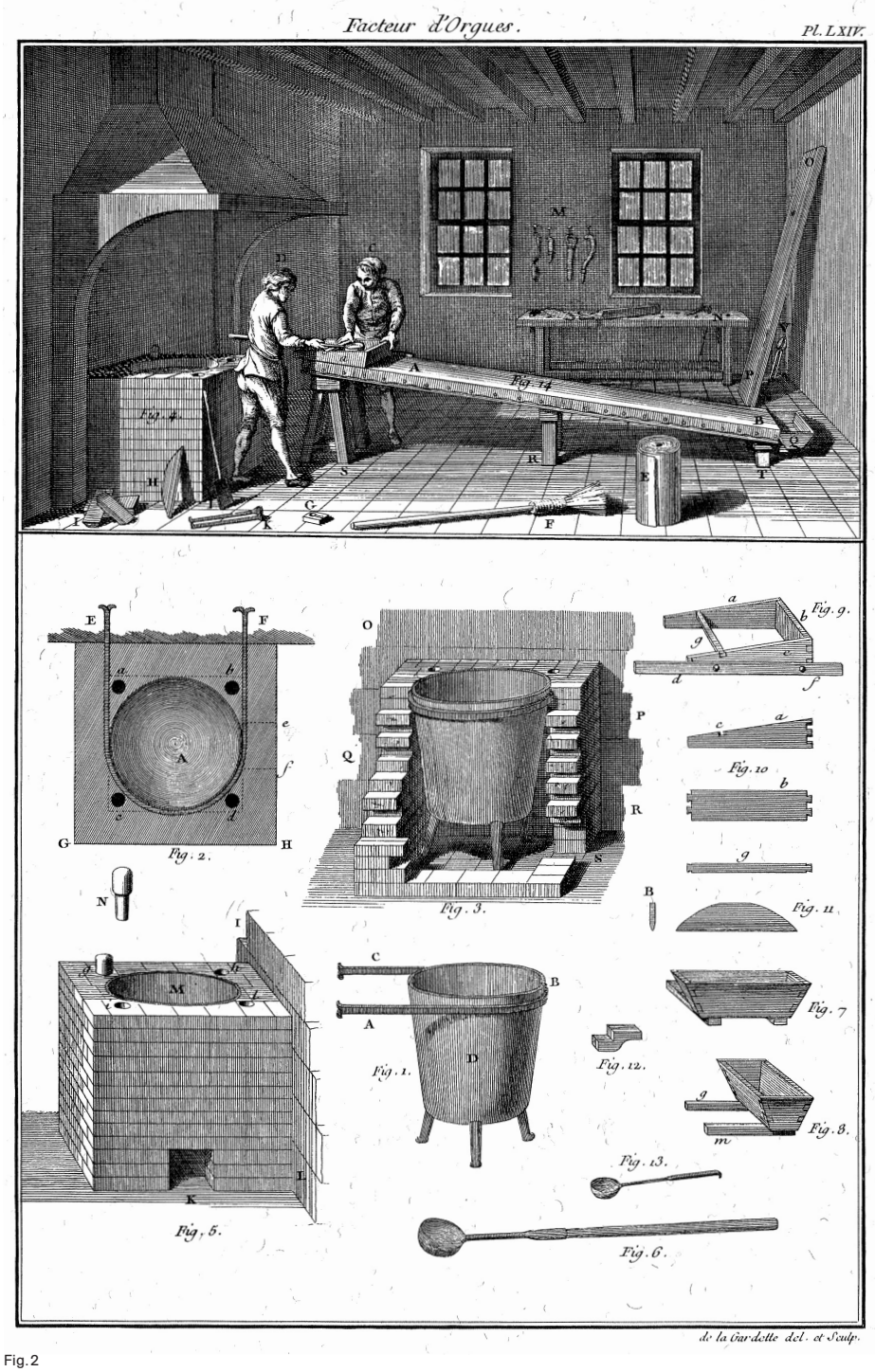

Fig.2

Figure 2. "Slanted casting bench, Plate LXIV from Dom Bédos, L'Art du facteur d'orgues (1770)." Reproduced from Speerstra 2003b, 173.

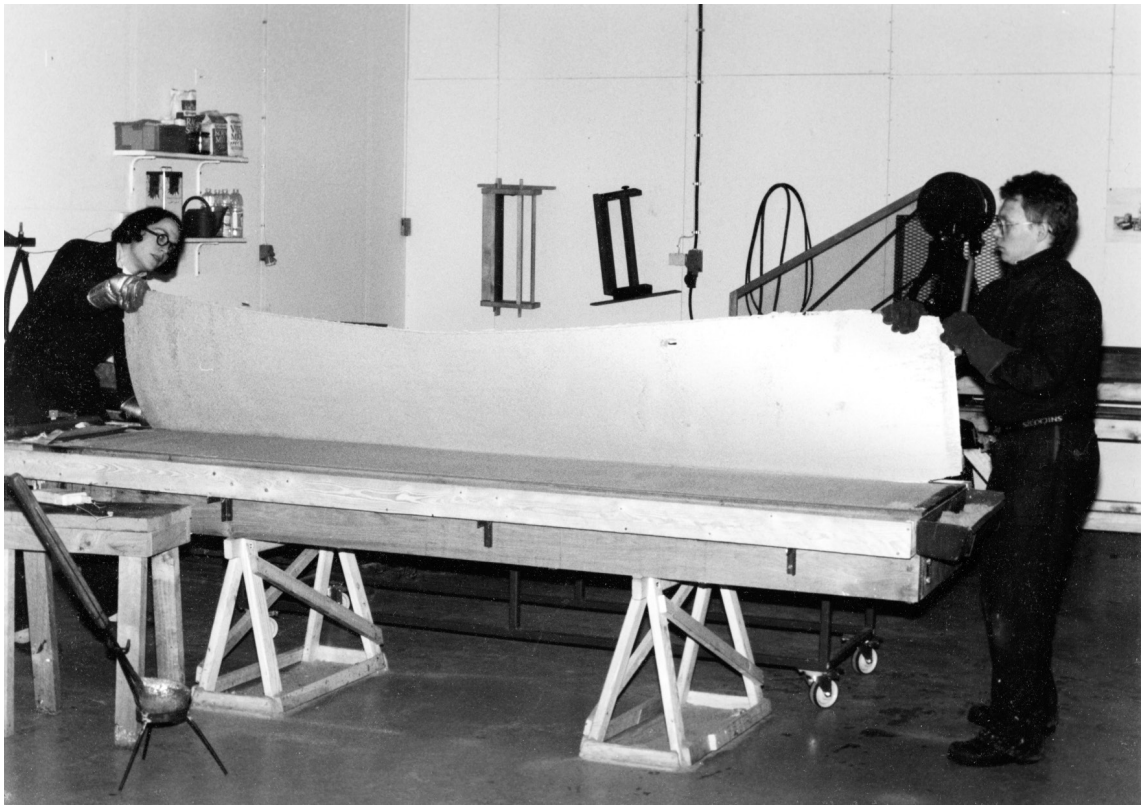

Fig.3

of sand or cloth for casting. It was established that casting on sand gives the metal a completely different quality than casting the pipes as is normally done today. Due to the sand bed beneath the molten metal, the metal cools quickly to a certain temperature that remains more or less constant, causing the pipe metal to become harder than modern pipe metal. The right type of sand, the right proportion of impurities or trace materials in the metal, and the right casting temperature are all factors that are thought to have vital importance for the end result. [Fig. 3]

Researchers in the project tried to relearn the practice of casting metal sheets for organ pipes by finding answers to such questions as: Did Schnitger cast on sand or cloth? If he cast on sand, what sand-layer thickness did he use? What type of sand did he use? Did he mix any oil or water into the sand; and if so, what type of liquid and how much did he use? (Carlsson et al. 2000).

THE SOUND OF THE SEVENTEENTH CENTURY

The desired end result of the project was to have built a replica of a North German Baroque organ that sounded good, or, more precisely, that sounded as good as the organs that were built by Arp Schnitger. To do so, the researchers and builders had to learn the "pattern language" of Schnitger, a term they took from Christopher Alexander's book *The Timeless Way of Building* (1979), which was an important early philosophical reference for the project. To recreate the sound of the late seventeenth-century Baroque organ, the project had to

Figure 3. "Turning the cast sheet onto a rolling cart. Sand can be seen clinging to the underside of the sheet." Reproduced from Speerstra 2003b, 212.

produce a wide variety of skills and knowledge. How can we understand this ambitious project in terms of the three symmetries that I outlined above?

First, from an STS perspective the question is not whether it is true or false that the organ in Gothenburg actually sounds as good as the lost Schnitger organ in the Lübeck Dom on which it was modelled. Instead, we should focus on work that has been done to make it true, or, to put it more precisely, to convince relevant communities of organ scholars, organ players, and organ builders that the replica sounds as good as a Schnitger. To do so, the researchers did computer simulations, relearned old skills, and studied existing organs. They invited people to come to Gothenburg to play the organ and listen to it. They produced extensive documentation of the whole process and organised concerts and conferences.

Second, it is clear that in the building of the Örgryte organ the cognitive, the social, and the material cannot be separated. The researchers could not have learned as much as they did if they had not actually built the instrument. The pipes stand as material arguments for the claim that the way the pipe metal has been cast renders a tone quality that matches the old pipes in a Schnitger organ. To assess this claim, we can only listen and compare, and to do so we have to become experts. But the organ can also be seen as embodying a discourse on the importance of historically informed performance practices.[10] In STS terms, and more specifically using a concept of Bruno Latour (2005), we can understand the organ as an *assemblage*, a term that tries to capture the hybrid character of its ontology.

How about the third symmetry? I would argue that the various practices and knowledge that went into the building of the Örgryte organ cannot a priori be qualified as either scientific and cognitive or artistic and skills-based. Computer simulations and measurements in a full-scale model of a wind system were not conclusive in verifying the claim that the organ sound was artistically as interesting as that of the remaining Schnitger organs. To create a convincing argument about the artistic quality of the sound, this knowledge had to be combined with the historical knowledge of existing instruments. Metallurgic knowledge as well as the experience of relearning old casting skills was needed to support an artistic argument on the sound quality of the organ pipes.

We could take the inauguration of the organ in the Örgryte church as the end of the project. As a musical instrument, it was ready; the process of building it was documented. Yet the situation described at the beginning of this article shows that the organ is now used in experimental settings, in addition to being

10 Since the days of pioneering recordings of the works of Monteverdi and Bach by Harnoncourt and Leonhardt, Baroque and Classical repertory has become the domain of specialised conductors, musicians, ensembles, and orchestras. European early music, which nowadays includes music from as recently as the 1920s, has been reinterpreted and recorded in a wide variety of historically informed performances to become an essential part of modern music culture. This development would not have been possible without the flourishing development in instrument building and restoration, making it possible for musicians to play string, wind, and keyboard instruments from different periods. The research on instrument building and restoration was not just organological in character, but was part of an animated debate on "historically informed / inspired performance practice (HIP)" (see Lawson and Stowell 1999; Haynes 2007).

used as a musical instrument. As such, it is a place where new knowledge is being produced, as could be seen in the case of the mechanical finger. Retelling the story of designing and building the North German Baroque Organ in STS terms unveils its hybrid and distributed character. It is many things at the same time. When played by organists it is a musical instrument. When studied by organ researchers, it is an experimental setting. In this article, it is an exemplary case in a reflection on the nexus of STS and artistic research. It is an object that allows asking many different types of questions.

AN ORGAN AS A SPIDERWEB

To further develop these multiple views of the Örgryte research organ, I will draw on the work of Hans-Jörg Rheinberger. As a historian of science, Rheinberger has focused on the practices of scientists, especially molecular biologists. Like Bruno Latour, he has a keen eye for the materiality of artefacts in laboratories.[11] And like Shapin and Schaffer, he does not make a distinction between scientific ideas and their discursive unfoldings, on the one hand, and the backgrounds or contexts of scientific practice, on the other. The question I want to answer is: How can we apply Rheinberger's notion of experimental systems to research organs and, by so doing, create common ground between STS and artistic research?

Experimental systems are characterised by the objects of investigation, or "epistemic things," and the experimental apparatus that consists of elements that are well understood, the "technical objects" (1997, 24–31). In an article in the *Neue Zürcher Zeitung* in May 2007, Rheinberger compared experimental systems to spider webs. They are arrangements in which we are able to catch something, though we do not know exactly what that something is or even when it will come. Experimental systems are "surprise generators," Rheinberger claims, or "machines for making the future":[12] "They are not simply experimental devices that generate answers; experimental systems are vehicles for materializing questions. They inextricably cogenerate the phenomena or material entities and the concepts they come to embody. Practices and concepts thus 'come packaged together'" (Rheinberger 1997, 28). The essence of this quotation is the assertion that in scientific experiments propositional knowledge cannot be separated from the material assemblage that is set up. It is precisely in and through creating this material assemblage that our understanding takes shape. From this perspective, there is no reason to treat the experimental

11 I will not elaborate the finer nuances of the critical debate between Latour and Rheinberger and the differences in their respective positions.

12 Rheinberger takes the notion of "machines for making the future" from the French biologist François Jacob, winner of a Nobel prize and author of "Time and the Invention of the Future." Rheinberger's concept of "epistemic thing" has been taken up by Karin Knorr Cetina (2001). She speaks of "epistemic object." Knorr Cetina underlines the openness and complexity as well as the question-generating capacities of epistemic objects. "Objects of knowledge appear to have the capacity to unfold indefinitely. They are more like open drawers filled with folders extending indefinitely into the depth of a dark closet. Since epistemic objects are always in the process of being materially defined, they continually acquire new properties and change the ones they have. But this also means that objects of knowledge can never be fully attained, that they are, if you wish, never quite themselves" (Knorr Cetina, 2001, 181).

setting of a research organ differently than a biological experiment. The question then becomes: What kinds of understanding are made possible through the research organ; and, more importantly for the debate on artistic research, what are the aesthetic dimensions of these understandings?

The research organ in Gothenburg was built to relearn a lost pattern language. The epistemic thing in the project, I would say, is this pattern language, the unique combination of knowledge, aesthetic ideals, and skills that enabled Schnitger to build great organs. It is precisely the aesthetic appreciation of these organs that leads researchers to study and relearn these skills and knowledge. The argument that pipes cast on sand sound better can only be made convincingly if it is actually materialised and performed. As the multiple wind systems make clear, there is also an element of demonstration in the research organ; to count as an artistically relevant parameter, it has to be demonstrated how different wind flows change the character of the tone. To put it in more general terms, the experimental system of the research organ not only renders new understandings of the pattern language of Schnitger, it *enlarges* the collection of epistemic things that turn out to be of artistic relevance—not only for the organ player, or a community of critics and experts, but also for the audience. The research organ emerges as an assemblage that enables us to articulate problems as artistic and construct discursive and material arguments for aesthetic choices.

Shapin and Schaffer wrote the story of the air-pump and showed how the matters of fact that were produced in Boyle's experimental settings cannot be seen as isolated snippets of knowledge; through myriad connections, they created a world. The mechanical finger at the console of the research organ in Gothenburg is part of an epistemic system that eventually transcends the material boundaries of the organ case and even the Örgryte church. It unfolds into a whole range of new questions: Why do we find some sounds more interesting and pleasing than others? Why do we want to hear the sound of old pipes? Why do we think that the pressure of the wind in an organ should create subtle variations in order to sound like a human voice? To answer these questions, future knowledge has to be developed and lost skills may have to be learned. The results of this research cannot be categorised a priori as true or false, social or material, or even scientific or artistic. The STS perspective developed in this article suggests that the reconstruction of the air pump of Robert Boyle and the organ that Schnitger built in Lübeck help extend our understanding of the actual *work* of producing knowledge and creating art as a form of artistic research.

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REFERENCES

Alexander, Christopher. 1979. *The Timeless Way of Building*. New York: Oxford University Press.

Alpers, Svetlana. 1983. *The Art of Describing: Dutch Art in the Seventeenth Century*. Chicago: University of Chicago Press.

Bijsterveld, Karin, and Peter Frank Peters. 2010. "Composing Claims on Musical Instrument Development: A Science and Technology Studies Contribution." *Interdisciplinary Science Reviews* 35 (2): 106–22.

Carlsson, Anders, Hans Davidsson, Pamela Ruiter-Feenstra, Su Dunthorne, and Joel Speerstra. 2000. *Tracing the Organ Masters' Secrets: The Vision, the Process, the Goal; The Reconstruction of the North German Baroque Organ for Örgryte Nya kyrka*. Gothenburg: Göteborg Organ Art Center / Göteborg University.

Cornell University College of Arts and Sciences. 2010. "The Cornell Baroque Organ Project." Cornell University, CornellCast video, 08:21. Accessed 6 June 2013. www.cornell.edu/video/cornell-baroque-organ-project.

Galison, Peter. 1987. *How Experiments End*. Chicago: University of Chicago Press.

Gomart, Emilie, and Antoine Hennion. 1999. "A Sociology of Attachment: Music Amateurs, Drug Users." In *Actor Network Theory and After*, edited by John Law and John Hassard, 220–48. Oxford: Blackwell Publishing.

Haynes, Bruce. 2007. *The End of Early Music: A Period Performer's History of Music for the Twenty-First Century*. New York: Oxford University Press.

Jorink, Eric, and Bart Ramakers, eds. 2011. *Art and Science in the Early Modern Netherlands*. Zwolle: Waanders.

Knorr Cetina, Karin. 2001. "Objectual Practice." In *The Practice Turn in Contemporary Theory*, edited by Theodore R. Schatzki, Karin Knorr Cetina, and Eike von Savigny, 175–88. London: Routledge.

Latour, Bruno. 1988. *The Pasteurization of France*. Translated by Alan Sheridan and John Law. Cambridge, MA: Harvard University Press. First published 1984 as *Les Microbes: Guerre et paix suivi de irréductions* (Paris: A. M. Métailié).

———. 1990. "Postmodern? No, Simply *A*modern! Steps towards an Anthropology of Science," essay review of *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life*, by Steven Shapin and Simon Schaffer. *Studies in History and Philosophy of Science* 21 (1): 145–71.

———. 1993. *We Have Never Been Modern*. Translated by Catherine Porter. Cambridge, MA: Harvard University Press. First published 1991 as *Nous n'avons jamais été modernes: Essai d'anthropologie symétrique* (Paris: La Découverte).

———. 2005. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Lawson, Colin, and Robin Stowell. 1999. *The Historical Performance of Music: An Introduction*. Cambridge: Cambridge University Press.

Nowotny, Helga. 2010. Foreword to *The Routledge Companion to Research in the Arts*, edited by Michael Biggs and Henrik Karlsson, xvii–xxvi. Abingdon, UK: Routledge.

Peters, Peter. 2009. "Retracing Old Organ Sound: Authenticity and the Structure of Artistic Arguments." *Krisis* 1. Accessed 05 May 2013. http://www.krisis.eu/content/2009-1/2009-1-02-peters.pdf.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

———. 2007. "Man weiss nicht genau, was man nicht weiss: Über die Kunst, das Unbekannte zu erforschen." *Neue Zürcher Zeitung*, 5 May. Accessed 06 May 2013.

http://www.nzz.ch/aktuell/startseite/articleELG88-1.354487.
Shapin, Steven, and Simon Schaffer. 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.
Speerstra, Joel. 2003a. "An Introduction to the North German Organ Research Project." In Speerstra 2003b, 15–20.
———, ed. 2003b. *The North German Organ Research Project at Göteborg University*. Gothenburg: Göteborg Organ Art Center / Göteborg University.
Snyder, Kerala J. 2002a. "Organs as Historical and Aesthetic Mirrors." In Snyder 2002b, 1–22.
———. 2002b. *The Organ as a Mirror of Its Time: North European Reflections, 1610–2000*. New York: Oxford University Press.
Star, Susan Leigh, and James R. Griesemer. 1989 "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–1939." *Social Studies of Science* 19 (3): 387–420.
van Saaze, Vivian. 2009. "Doing Artworks: A Study into the Presentation and Conservation of Installation Artworks." PhD thesis, Maastricht University / Netherlands Institute for Cultural Heritage.
Vogel, Harald. 2003. "Organ Restoration in the Twentieth Century." In Speerstra 2003b, 341–45.
Yaneva, Albena. 2003. "When a Bus Met a Museum: Following Artists, Curators and Workers in Art Installation." *Museum and Society* 1 (3): 116–31.
Yokota, Munetaka. 2003. "Historical Pipe Metal Casting Techniques in Seventeenth-Century North Germany." In Speerstra 2003b, 165–86.

A Laboratory View of Art

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INTRODUCTION

After four decades of laboratory studies the "laboratory" has become an almost mystical place: a place where "facts are constructed" and "knowledge becomes manufactured" (Knorr Cetina 1981; Latour and Woolgar 1979); a place where one can watch ideas condensing and "epistemic things" come into being (Rheinberger 1997) while researchers carry out arcane procedures with strange apparatus, which the philosopher or sociologist at work tries to decipher. Like an anthropologist, the philosopher or sociologist has to take part in the "laboratory life"—methodologically termed "participatory observation"—and has to look at the research as he or she would observe indigenous peoples. In order to see "science in action" (Latour 1987) a "showdown from texts to things" has to be accomplished, if he or she no longer wants "to believe the text that we read in *Nature*," but wants "to believe [his or her] own eyes" (Latour 1987, 64, 66). Thus, generations of young philosophers and sociologists have fanned out and entered all kinds of scientific laboratories, producing plenty of literature on their experiences and establishing the new and interdisciplinary field of science and technology studies (STS). However, what is never told by these narratives is that laboratory life is boring and laboratories are among the ugliest places in the world. A scientist working in the laboratory needs extraordinary abilities, not least among them patience and persistence. The story of synthesising proteins in the test tube, for instance, as told by Hans-Jörg Rheinberger (1997) covers a period of fifteen years of laborious and exhausting work in the laboratory accompanied by small successes but major setbacks until a final breakthrough was achieved. Even such a common instrument as the thermometer required 150 years of development until a reliable version became accessible as the mercury thermometer (Böhme, van den Daele, and Krohn 1977; Chang 2004).

Thus, it is interesting that terms like "laboratory," as well as "experiments" and "research," have become prominent and exciting metaphors in contemporary art discourse, in particular in the ongoing debate on "artistic research" (F. Popper 1987; Young 2001; Balkema and Slager 2004; Macleod and Holdridge 2006; Borgdorff 2006, 2009, 2012; Caduff, Siegenthaler, and Wälchli 2009; Bippus 2009; Dombois et al. 2012). As Henk Slager (2004, 12) has framed it: "While the traditional academic, artistic model could be described as one in which experiment is embedded in experience, the topical model is one which experience is embedded in experimentation." Although Slager emphasises that art can never produce "objective knowledge" as science can, artistic research "does satisfy a

number of fundamental research criteria, such as a focus on communication, a (self) critical attitude, and an emphasis on autonomous research" (ibid., 13). However artistic research is defined—as "research into art," "research for art," or "research through art" (Frayling 1993; see also Borgdorff 2006)—it shares at least two aspects with scientific research that can come under investigation in a laboratory view of art. These two aspects are locality and stability. There is a location where art is created (usually the studio); and there is the fact that art also has to "stabilise" something that can be presented, whatever this is. For instance, Rheinberger's (1997) study on synthesising proteins in the test tube is nothing other than a reconstruction of the decade-long attempt to stabilise new facts. Thus, locality and stability are two major concepts in research and can also be used for developing a laboratory view of art.[1]

PLACES FOR STABILISING FACTS

Since the seventeenth century, laboratories have become the traditional places for stabilising new facts. Stuffed with fancy equipment for manipulating "nature," their aim is "the finding out of the true nature of all things" for human control over nature (Bacon [1627] 1999, 167). Over the past centuries the lab realities have become detached from life-world realities and thus created an artificial domain, which is iteratively linked back to the life world by engineering and technology, both continuously modifying our life-world realities. Or, in other words: "The laboratory is a means of changing the world-related-to-agents in ways which allow scientists to capitalise on their human constraints and sociocultural restrictions" by modifying the "self-others-things" relation and the "phenomenal field" in which experience is made (Knorr Cetina 1992, 116).[2] Following Slager, artists today create "experiences embedded in experimentation" and thus also transform the phenomenal field, but do so in their studios rather than in the laboratory. Interestingly, compared to the breakup of the black box "laboratory" by laboratory studies since the 1970s, there has also been an opening of the inner world of the artist's studio since Lucas Samaras transferred his studio to Green Gallery in New York City in 1964. What became visible was the "order of things" of a location, the studio, where the meaning of objects is created, becoming art at the other (public) location, the gallery (O'Doherty, 2008). The congruence of both locations became transparent; and this congruence applies in science as well, where the meaning of objects—called epistemic objects in the terminology of Rheinberger (1997)—is created at one location, the laboratory, becoming science at the other (public)

1 The emphasis of this paper lies in exploring neither what "artistic research" is nor how its institutional setting can be defined compared to traditional academic structures. In fact it is an attempt and plea to do "research on art" in terms of exploring artistic practices and the formation of artistic concepts. Both aspects—practices and concept formation—are the usual targets of philosophy-inspired laboratory studies, while communication and social interaction are those of sociology-inspired laboratory studies. However, the hope is that a laboratory view of art can help achieve a better understanding and insights about contemporary developments in the art world.

2 Karin Knorr Cetina refers to Maurice Merleau-Ponty's concept of "Moi-Autrui-les-choses" (Merleau-Ponty 2012).

location, the scientific journals. It is precisely this transformation that the laboratory view inverts as a "showdown from texts to things" in order to understand the epistemic procedures.

However, the uncovered studio unveils even more. Like museums that show the various "spaces of epochs" (Epochenräume), the studio unveils not just the individual but also the epoch-tied space (O'Doherty 2008). Samaras's studio unshrouds a quite different environment of artistic procedures than does, for instance, Olafur Eliasson's studio: the first a location of chaotic individualism, the latter an organised place for a large entourage of co-workers. But these places differ not just according to the individuality of their owners; they also display art at different stages, following different models.[3] In the case of Eliasson's studio we encounter the (new) model of a "transdisciplinary studio," a place composed of "a large design office, a series of test spaces, a workshop, an archive and library, and a warren of studio space that host the Institut für Raumexperimente (Institute for Spatial Experiments)" (Coles 2012, 9). This impressive conglomeration of locations offers space to artists, photographers, architects, and others for transdisciplinary collaboration. Such a variety of locations is also well known to science—individual laboratories, high-tech laboratories, big science laboratories, etc.—and has been studied by historians and philosophers (e.g., Galison and Thompson 1999). And, more importantly, such locations show in a material way "scientific revolutions" and changes in epistemic formation. For instance, a contemporary physicist could hardly make use of James Clerk Maxwell's Cavendish laboratory at Cambridge, which he had designed and set up in the 1870s. The reason for this lies in the co-evolution of "technical objects" and "epistemic things" in experimental systems, permanently influencing and updating each other and thus creating scientific progress. "Epistemic things are the unknown, or vaguely known, objects of investigation that are the counterparts of experimental conditions (the technical objects). They do not simply yield in docile fashion to the technologies of investigation" (Mody and Lynch 2010, 3; see also Rheinberger 1997, 30–31). In other words, there is a story of "epistemic objects" coming into being, but there is also a story of "technical things" or the laboratory, respectively, materially embodying the state-of-the-art of current development. A history of technical objects can also be told for art, but such an investigation of the studio as an indicator of development in art is still lacking. Perhaps Coles's (2012) study on *The Transdisciplinary Studio* can be seen as a very first step in this direction, based on the methods of laboratory studies: interviews and participatory observation.[4]

3 I will not refer to the post-studio discussion (Buren 1979; Jones 1996; Diers and Wagner 2010), as this debate does not address the questions of interest in this paper. Furthermore, the post-studio debate questions the studio as the location of artistic production as, for instance, John Baldessari has done in his "Post Studio Art" class at CalArts (Baldessari 1992). In contrast to this, the studio as the location of artistic production is of interest for a laboratory study view of art, although this does not imply the romantic view of the "sacred" studio. Perhaps temporary studios and similar phenomena could become objects of investigation for a laboratory study of art. However, a definite location is necessary to conduct such a study.

4 Other rare examples of participatory observation in the art world are Sarah Thornton's brilliant 2008 study Seven Days in the Art World and Ingo Niermann and Erik Niedling's 2011 investigation of The Future of Art.

STABILISING FACTS

However, the more elaborate story to be uncovered is the formation of epistemic, or in art, aesthetic things—both "vaguely known objects of investigation." This vagueness is what makes it so difficult to investigate these objects, be they in the laboratory or the studio. Perhaps Rheinberger's study can be used as a guide to explore these objects in an art context as well. A close reading of his text unveils the process of stabilising facts in the laboratory as the centre of research work. Because epistemic objects are vague and non-material, only indices or "traces" of them can be found. According to Rheinberger, these traces are nothing other than generated lists of the vague objects' activities and properties. Rheinberger refers here to Latour's concept of the list as a tool for "written answers to trials":

> Observe that in the laboratory, the new object *is named after what it does*: "something that inhibits the release of growth hormone." [The researcher] then invents a new word that summarises the actions defining the thing... Now that [it] is named and accepted, its properties have changed and are not of interest to us at this point. What counts for us is to understand the new object just at the moment of its emergence. Inside the laboratory the new object is *a list of written answers to trials*. (Latour 1987, 87)

Each change in the list redefines the epistemic object (Rheinberger 1997, chapter 2). This operational re-coding, meticulously documented in the laboratory journal, unveils the process of an epistemic object coming into being, a process that can take months and years of research. The completion of the research process is marked by the stabilisation of the epistemic object as a fact; thus it becomes publishable and ready to become the starting point of new research cycles. Thus, a cascade of new research can be initialised by an epistemic object; but it can also fall into oblivion. However, without sufficient stabilisation an epistemic object would disappear into the laboratory's nirvana.

It is now the task of philosophers or sociologists doing STS to observe the traces in the manifestation of epistemic objects ultimately listed in the laboratory journal. This is laborious work that requires weeks and months of participatory observation and countless hours of interviews and conversation, but also extensive studies of related literature and presentations. During this work the traces of epistemic objects, seen from the perspective of STS, become visible and with them the procedures of laboratory research. Then the philosopher or sociologist has to illustrate these procedures and processes in his or her own words to create a narrative of the laboratory. The above-mentioned laboratory studies document this process.[5]

5 There is a field of art where the work of an artist could probably be evaluated as tracing and displaying "epistemic objects." The instruments of choice are diagrams and maps, because the "reductive power of diagrams" assign them as appropriate "instruments of cognization" and "of enlightenment" (Schmidt-Burkhardt 2012, 62; see also Harmon 2003; Harmon and Clemans 2009; Leeb 2012), thus helping vague epistemic and / or aesthetic objects to be comprehended. Examples are the diagrams by Adelheid Mers depicting her thoughts on Applied Aesthetics (2001), those by the Bureau d`etudes exploring the Self Economy (2008), and the map by Ward Shelley investigating the question Who Invented the Avant-Garde, ver.1 (2006). See Mers (2013); Bureau d'Études (2013); Shelley (2013).

CHANGING PHENOMENAL FIELDS

While stabilising facts, the researcher in the laboratory continually changes the phenomenal field. Karin Knorr Cetina has aptly described this process as the reconfiguration of the system of "self-others-things."

> The system of self-others-things for Merleau-Ponty is not the objective world independent of human actors or the inner world of subjective impressions, but the world-experienced-by or the world-related-to agents. What laboratory studies suggest is that the laboratory is a means of changing the world-related-to agents... The laboratory is an enhanced environment which improves upon the natural order in relation to the social order. (Knorr Cetina 1992, 116)

This is possible because natural objects, according to Knorr Cetina, are not fixed but characterised by their malleability. Researchers in the laboratory rarely work with natural objects. Usually they work with representations and traces of them. "Rather they work with object images or with their visual, auditory, electrical, etc., traces, with their components, their extractions, their purified versions" (ibid.). Researchers in the laboratory do not have to deal with a natural object "as it is," "where it is," and "when it happens." In fact, the goal of laboratory research is a highly artificial (and, thus, unnatural) one; it aims at the "detachment of the objects from a natural environment and their installation in a new phenomenal field defined by social agents" (ibid., 117). Laboratory practices are practices of detachment and, simultaneously, of creation of new and epistemic versions of natural objects and phenomena.

However, does this not resemble the work of artists? The installation of objects and phenomena in a new phenomenal field is a basic category for every creative activity in the laboratory as well as in the studio. Of course, research in scientific laboratories stands on a four-century old tradition of detachment practices manifested in the laboratory's technical things like measurement devices and procedures. This tradition prevents laboratory research from being arbitrary and particular as it defines the ground for general knowledge. However, art is also familiar with such traditions: for instance, the general application of central perspective in Renaissance artists to depict objects in the "true" way; but also proportion theory and other general knowledge that has been studied extensively by the artist. While contemporary art does not necessarily apply this general knowledge anymore, it still transforms objects and phenomena in a new phenomenal field and has developed a broad variety of individual detachment practices. These individual detachment practices are of interest for a laboratory study view of art.

DISCUSSION

Why should one conduct a laboratory study of art? In the foreword to *Thinking through Art* (Macleod and Holdridge, 2006) an interesting answer to this question is provided by Christopher Frayling.

> There's the confusion between research (as process) and research degrees (as qualifications). There's the confusion between advanced practices and research. There's the confusion about whether or not, or in what sense, research should result in communicable knowledge. There's the confusion about how the traditional procedures of research—finding a subject, searching the literature, selecting a perspective, contributing to knowledge and understanding—might apply in the fine art area. And there's the deep-seated confusion, around since the 1960s, about whether it is even appropriate to grant university degrees for studio practices. Discussions of these (and related issues) have usually ended up with both feet planted firmly in the air, when it has become increasingly important to plant them firmly on the ground. (Frayling 2006, xiii)

Obviously there is a lot of confusion out there that begs for research. As Frayling argues, the deeper reason for the need to sort out the confusion is the unease of artists working in academia. Thus, he pleads for a "radical academy" with a "distinctive research culture... a culture which examines and understands its own assumptions... [and which] is distinct from advanced practice in the professional world of art" (Frayling 2006, xiv). In order to achieve this aim, "its own assumptions" and "procedures" have to be made cognisable and visible. The tool of laboratory studies, therefore, can be helpful for exploring the conditions of epistemic and aesthetic formation in contemporary art. Often arguments have been advanced that research in art, in contrast to science, is not general but highly particular; it is not methodologically constrained, but radically individual; it is not communicable in theories, but diverse in its presentation (e.g., Young 2001). While this might be true, two things must be considered. First, this view of science usually does not apply to the reality of science; laboratory studies, in particular, have uncovered this discrepancy between science's public image (usually the Popperian research style of theoretical physics)[6] and the real actuality of the sciences. Science is, by far, not as general, methodologically constrained, and theoretically elaborated as one might think—in particular scientific research in laboratories. The concept of "scientific research" is a vague one enfolding a broad variety of practices, procedures, and standards. For instance, the biological style of research would not be accepted in physics, and the physical style could not be applied to chemistry. The interesting outcome of the plethora of laboratory studies on science and technology is that a diverse universe of research styles and "contexts of discoveries" has become apparent during the past decades. The second consideration is more relevant, however, because it demands a better understanding of epistemic formation in the arts, since art, too, is subject to methodological and epistemic mutuality despite its high degree of individuality, not only because it has to apply the traditional procedures of research as listed by Frayling in his above mentioned statement but also because artists can refer to only a limited spectrum of human understanding and ways of cognitive reflection. Therefore artists, too, have to stabilise "facts" in order to present something. How they do so and what detachment practices are employed still has to be discovered by "studio studies."

6 See Karl Popper ([1959] 1992).

That studio studies do not necessarily have to copy the method of laboratory studies is obvious, although interviews and participatory observation can be helpful tools even though they hail from visual anthropology. An interesting alternative is outlined by Sarat Maharaj, who applied the notion of "sounding" to artistic research. Metaphorically, he "proposed sending out impulses and receiving a topological image of the surroundings as a reply—similar to sonar or ultrasound" as a method of "approaching complex subjects in a communicative sphere that is riddled with incompatible ways of living and knowing and filled with cultural difference and intranslatables" (Kirschner, 2012).[7] This could be developed, not only as a method of artistic research but also as a method for studio studies. The artist and researcher Roman Kirschner, in response to Maharaj's idea, highlighted the sound work of Chris Watson on orcas using echolocation for hunting, presented at Brussels Museum of Natural Science in 2010. Watson explored the spatial representations that orcas create by their sonar clicks as the clicks are reflected back from the environment. Thus, they transform the sound-based responses into maps. However, the intriguing discovery biologists made was that orcas can probably also retransmit the spatial response and thus share their view to create a multi-perspective, collective map. "Even if this supposition of a shared—or to use Maharaj's expression—'agglutinative' perception/thinking of whales does not prove to be actually the case, it seems to be a good starting point to ponder about collective sounding, compositionism and further modes, channels and formats of exchange between people involved in Art Research and thus involved in creation" (ibid.).

Related to the laboratory study view of art, studio studies could help to gain more knowledge on the multi-perspective, collective knowledge created by individual artists. And it could achieve this with a multi-perspective, collective approach to investigation. How such a kind of research might look has yet to be developed. The possibility for such studio studies was explored in an experimental way for the very first time at the Academy for Media Arts Cologne during the preparation of the *Heavy Matter* show in cooperation with the International Symposium on Electronic Arts (ISEA) 2010. This show was conceived during the course of three seminars between 2009 and 2010 as a contribution to the current debate on materiality (material turn) in terms of "artistic research." The dynamic of creating artworks for a conjoint and topic-related show by a group of twenty art students and artists was observed (Gramelsberger 2010). In addition to a variety of dynamic patterns in epistemic and social formation that became apparent during the period of observation (2009–10), an interesting finding was that, as in the laboratory, the artists are challenged by the materials and procedures they use. In laboratory studies this is called the "agency" of the objects and procedures, an interesting research topic in itself (Latour 2005). However, the more surprising observation was that for every artwork

7 Roman Kirschner refers to Sarat Maharaj's keynote lecture during the SARN (Swiss Artistic Research Network) conference "We, the Public!" held from 26–27 April 2012 at Lucerne. The proceedings of this conference are in preparation.

the students/artists were challenged by the transgression from epistemic to aesthetic (and *not* vice versa). This process of transgression was sometimes very laborious, sometimes very easy, depending on the students/artists' individuality and the actual piece of work. What made it so difficult was the aim, as many students/artists articulated it, that the artwork "should become an experience" and that the ideas behind the work, which they had developed during the course of the seminars, should be "palpable." Scientists could write their findings down directly, but in the context of art this would be extremely boring. Thus, "artists-as-researchers" are challenged by the transgression from epistemic to aesthetic, for which there are no conventions yet. Obviously, however, this transgression from epistemic to aesthetic is much more an intrinsic part of contemporary art than in earlier periods when art was less individualised, more bound to convention, and less concerned with epistemic aspects. Related to this challenge another interesting finding emerged. The study showed that research-oriented approaches to art do not necessarily fulfil art-market criteria. Obviously this is less a matter of the will to conform to art-market criteria in ensuring saleable art products and more a consequence of the nature of research in exploring new access points to themes, places, and work strategies. For instance, the trend towards open-source, low-tech, and participatory strategies is not necessarily in support of gallery requirements, as there is often no product or presentable outcome at all. One of the students called it the "anti-gallery art production." This poses the question: What if, with "artistic research," the academy opens up a new (public) space for art besides the traditional locations of galleries, museums, and fairs? What this could mean for the future is unclear so far. However, the laboratory study view of art can help make ongoing developments more apparent and find criteria (like the epistemic/aesthetic transgression) that characterise "artistic research."

REFERENCES

Bacon, Francis. (1627) 1999. *New Atlantis*. In *Three Early Modern Utopias: Utopia; New Atlantis; The Isle of Pines*, edited by Susan Bruce, 149–86. Oxford: Oxford University Press.

Baldessari, John. 1992. "Oral History Interview with John Baldessari, 1992 Apr. 4–5." Archives of American Art, Smithsonian Institution. Accessed 16 January 2013. http://www.aaa.si.edu/collections/oralhistories/transcripts/baldes92.htm.

Balkema, Annette W., and Henk Slager, eds. 2004. *Artistic Research*. Amsterdam: Rodopi.

Bippus, Elke, ed. 2009. *Kunst des Forschens: Praxis eines ästhetischen Denkens*. Zurich: Diaphanes.

Böhme, Gernot, Wolfgang van den Daele, and Wolfgang Krohn, eds. 1977. *Experimentelle Philosophie: Ursprünge autonomer Wissenschaftsentwicklung*. Frankfurt: Suhrkamp.

Borgdorff, Henk. 2006. *The Debate on Research in the Arts*. Sensuous Knowledge: Focus on Artistic Research and Development 2. Bergen: Bergen National Academy of the Arts.

———. 2009. *Artistic Research within the Fields of Science*. Sensuous Knowledge: Focus on Artistic Research and Development 6. Bergen: Bergen National Academy of the Arts.

———. 2012. *The Conflict of the Faculties: Perspectives on Artistic Research and Academia*. Leiden: Leiden University Press.

Bureau d'Études. 2013. Homepage of Bureau d'Études (Léonore Bonaccini and Xavier Fourt). Accessed 30 June. http://bureaudetudes.org.

Buren, Daniel. 1979. "The Function of the Studio." Translated by Thomas Repensek. *October* 10 (Autumn): 51–58.

Caduff, Corina, Fiona Siegenthaler, and Tan Wälchli, eds. 2009. *Kunst und künstlerische Forschung / Art and Artistic Research: Music, Visual Art, Design, Literature, Dance*. Zurich Yearbook of the Arts 6. Zurich: Zürcher Hochschule der Kunste / Scheidegger & Spiess.

Chang, Hasok. 2004. *Inventing Temperature: Measurement and Scientific Progress*. Oxford: Oxford University Press.

Coles, Alex. 2012. *The Transdiciplinary Studio*. Berlin: Sternberg Press.

Diers, Michael, and Monika Wagner, eds. 2010. *Topos Atelier: Werkstatt und Wissensform*. Hamburger Forschungen zur Kunstgeschichte 7. Berlin: Akademie Verlag.

Dombois, Florian, Ute Meta Bauer, Claudia Mareis, and Michael Schwab, eds. 2012. *Intellectual Birdhouse: Artistic Practice as Research*. London: Koenig Books.

Frayling, Christopher. 1993. *Research in Art and Design*. Royal College of Art Research Papers, vol. 1, no. 1. London: Royal College of Art.

———. 2006. Foreword to Macleod and Holdridge 2006, xiii–xiv.

Galison, Peter, and Emily Thompson, eds. 1999. *The Architecture of Science*. Cambridge, MA: The MIT Press.

Gramelsberger, Gabriele. 2010. "Heavy Matter: A Laboratory Study View." In *Heavy Matter*, edited by KHM Academy of Media Arts. Cologne: Academy of Media Arts. Published in conjunction with the exhibition of the same name shown as part of the International Symposium of Electronic Arts (ISEA) 2010.

Harmon, Katharine. 2003. *You Are Here: Personal Geographies and Other Maps of the Imagination*. New York: Princeton Architectural Press.

Harmon, Katharine, and Gayle Clemans. 2009. *The Map as Art: Contemporary Artists Explore Cartography*. New York: Princeton Architectural Press.

Jones, Caroline A. 1996. *Machine in the Studio: Constructing the Postwar American Artist*. Chicago: University Of Chicago Press.

Kirschner, Roman. 2012. "Sounding, Composition, Retransmission: Thoughts on Sarat Maharaj's Notion of Sounding in the Context of Art Research." *Liquid Things*, 27 September. Accessed 3 May 2013. http://www.liquidthings.net/?p=916.

Knorr Cetina, Karin. 1981. *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*. Oxford: Pergamon Press.

———. 1992. "The Couch, the Cathedral, and the Laboratory: On the Relationship between Experiment and Laboratory in Science." In *Science as Practice and Culture*, edited by Andrew Pickering, 113–38. Chicago: University of Chicago Press.

Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

———. 2005. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Latour, Bruno, and Steve Woolgar. 1979. *Laboratory Life: The Social Construction of Scientific Facts*. Beverly Hills, CA: Sage.

Leeb, Susanne, ed. 2012. *Materialität der Diagramme: Kunst und Theorie*. Berlin: b_books.

Macleod, Katy, and Lin Holdridge, eds. 2006. *Thinking through Art: Reflections on Art as Research*. Abingdon, UK: Routledge.

Merleau-Ponty, Maurice. 2012. *Phenomenology of Perception*. Translated by Donald A. Landes. Abingdon, UK: Routledge.

Mers, Adelheid. 2013. Homepage of Adelheid Mers. Accessed 30 June. http://adelheidmers.org.

Mody, Cyrus C. M., and Michael Lynch. 2010. "Test Objects and Other Epistemic Things: A History of a Nanoscale Object." *British Journal for the History of Science* 43 (3): 423–58.

Niermann, Ingo, and Erik Niedling. 2011. *The Future of Art: A Manual*. Berlin: Sternberg Press.

O'Doherty, Brian. 2008. *Studio and Cube: On the Relationship between Where Art is Made and Where Art is Displayed*. New York: Temple Hoyne Buell Center for the Study of American Architecture / Princeton Architectural Press.

Popper, Frank. 1987. "Technoscience Art: The Next Step." *Leonardo* 20 (4): 301–03.
Popper, Karl. (1959) 1992. *The Logic of Scientific Discovery*. London: Routledge. First published 1935 as *Logik der Forschung* (Vienna: J. Springer). English edition first published 1959 (London: Hutchinson).
Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.
Schmidt-Burkhardt, Astrid. 2012. "'Plötzlich diese Übersicht': Kunst unter dem diagrammatischen Imperativ." In Leeb 2012, 61–98.
Shelley, Ward. 2013. Homepage of Ward Shelley. Accessed 30 June. http://www.wardshelley.com/.
Slager, Henk. 2004. "Methododicy." In Balkema and Slager 2004, 12–14.
Thornton, Sarah. 2008. *Seven Days in the Art World*. New York: W. W. Norton.
Young, James O. 2001. *Art and Knowledge*. London: Routledge.

Artistic Practices and Epistemic Things*

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What does it mean to present art *as research*? What relationship exists between art—artworks, artistic practices—and the presentation of art as research in an academic context? This demarcation question is a hot item in the debate on the emergent field of artistic research. The debate often concerns issues of institutional or educational politics that are thought to be important for determining whether artistic research can be recognised as a type of academic or scientific research. Prominent issues are the standards needed to assess research by artists, the institutional rights to award third-cycle (doctoral) degrees in the arts, and the criteria to be applied by funding bodies in deciding whether to support research by artists.

Sometimes the focus is on issues from philosophy of science that pertain to artistic research. Do the usual criteria for doing academic research (concerning research questions, methods, and justifications) automatically apply to this new field of research? To what extent and in what respects do artistic research activities differ from those in other types of academic or scientific research? What are the similarities and differences between artistic research and research in the natural sciences, the social sciences, or the humanities?

I will focus here on the fundamental question of the epistemological status of artworks and art practices *as research*. How can things that are fundamentally polysemic—that seem to elude every attempt to tie them down, to define them—still function as vehicles of research? That is, how can they function not just as *objects* of research but also as the entities in which and through which the research takes place—and in which and through which our knowledge, our understanding, and our experience can grow. What is the nature of such an "object of research," particularly in terms of epistemology? What gives art the ability to generate new knowledge and understandings?

The foundational debate on artistic research needs input from the disciplines that concern themselves with the history, the theory, and the practice of the

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sciences: sociology of science, science and technology studies (STS), historical epistemology.[1] By the same token, the philosophy of science—or more broadly, our understanding of what academia is—can be furthered by the things that take place in the emergent field of artistic research. To help clarify the epistemological status of art in the research process, I shall draw on some recent insights achieved in research in the theory of science, focusing primarily on the work of Hans-Jörg Rheinberger, director of the Max Planck Institute for the History of Science in Berlin. Rheinberger studies the history and epistemology of experimentation in the life sciences, in particular molecular biology. I will argue that Rheinberger's ideas about the dynamics of experimental scientific practice—and the special status he assigns to "epistemic things" within those dynamics—may help elucidate the status of art within artistic research practices.

Rheinberger's work may be attributed to the movement in the philosophy of science that seeks to emancipate the "context of discovery" in relation to the "context of justification." It distances itself from the more empiricist and critical-rationalist notions of science that were in vogue until two decades ago. The goal is not only to understand the dynamics of scientific conduct but also to clarify the epistemology involved—that is, how knowledge is constituted in and through practices.

This "practice turn in contemporary theory" (Schatzki, Knorr Cetina, and von Savigny 2001)—inspired by Edmund Husserl, Martin Heidegger, and phenomenological tradition, as well as by the later work of Ludwig Wittgenstein and the pragmatist tradition—is manifest in a number of fields, including the cognitive sciences (e.g. Noë 2004), science and technology studies (e.g. Latour 1987, 1999; Latour and Woolgar [1979] 1986; Shapin and Schaffer 1985; Knorr Cetina 1999), and the study of social and cultural practices. As the context of discovery becomes liberated, practices and things take the places of theories and mental states. Embodied, situated, and enacted forms of cognition become more important to our understanding of research than world-mind representations and detached modes of rationality and objectivity.

EXPERIMENTAL SYSTEMS

What is the epistemological status of art in artistic research? Are artworks or art practices capable of creating, articulating, and embodying knowledge and understanding? And, if so, what kinds of artworks and practices do this (what is the ontological status of art here?) and how do they do it (the methodological status)?

As I have suggested above, work in an entirely different academic research domain—theoretical and historical research on experimental practice in the life sciences—can help clarify these issues.[2] In his study of the history and practice

1 See Rheinberger 2007. Helga Nowotny (2011, xxiii) has highlighted the importance of STS, and in particular of actor-network theory (ANT), for understanding artistic research "in this changing epistemological, institutional, and normative landscape in the bewildering zones of uncertainties."

2 In some quarters of the art world, the life sciences are a subject of keen interest. I will not be concerned here with crossovers between life sciences and the arts, such as in BioArt, but with the more fundamental question of the very relationship between art and knowledge.

of research in the natural sciences, Hans-Jörg Rheinberger has demonstrated that "experimental systems" are the centre and the motor of modern scientific research. Rheinberger's historical case studies, extending from the pre-war genetic experiments to present-day molecular biology, show that the dynamics of experimental systems can only be understood as an interplay of machines, preparations, techniques, rudimentary concepts, vague objects, protocols, research notes, and the social and institutional conditions in which these are employed. Experiments are not merely methodological vehicles to test (confirm or reject) knowledge that has already been theoretically grounded or hypothetically postulated, as classical philosophy of science would have it. Experiments are the actual generators of that knowledge—knowledge of which we previously had no knowledge at all. Experimental systems are "machines for making the future," as Rheinberger (2006a, 25/28[3]) has observed, citing François Jacob, the French biologist and Nobel Prize winner.

Experimental systems are characterised by the interplay and entwinement of "technical objects" and "epistemic things"—the technical conditions under which an experiment takes place and the objects of knowledge whose emergence they enable. The distinction is functional, not material: "Whether an object functions as an epistemic or a technical entity depends on the place or 'node' it occupies in the experimental context" (ibid., 27/30).[4] In this way, "epistemic things" may turn into technical objects or instruments, thereby ensuring the relative stability in the experimental system that enables new epistemic things to appear. Systems must be "differentially reproducible," Rheinberger argues, "if they are to still be arrangements where knowledge can be generated that lies beyond anything we could conceive or anticipate" (Rheinberger 2008, 19:28, my translation).[5] But it also works the other way round. Technical things, if deployed differently, may sacrifice their stability and diffuse into epistemological questions. In molecular biology, for instance, organisms, or other entities such as genes, could sometimes be things we *want to know* (epistemic things) and at other times be objects *through which we can know* (technical objects). Rheinberger speaks in this context of a synchronic intertwinement of the epistemic and the technical, and of a diachronic intertwinement of difference and reproduction.[6]

Rheinberger has deliberately chosen the term "thing" rather than "object" in order to signify the indeterminate, not yet crystallised status of the knowledge object. Epistemic things are "chronically underdetermined" (ibid., 14:30). Experimental systems must be sufficiently open to allow these indistinct things to come into view; enough space must be present to produce

3 Dual page references in texts by Rheinberger refer respectively to the German and the English versions (which may slightly differ).

4 "Ob ein Objekt als epistemisches oder als technisches funktioniert, hängt von dem Platz oder dem Knoten ab, den es im experimentellen Kontext besetzt."

5 "Experimentalsysteme müssen differentiell reproduzierbar sein, wenn sie Arrangements bleiben sollen in denen Wissen generiert wird, das auch einmal jenseits dessen liegt was man sich hat vorstellen und was man hat antizipieren können." Cf. Rheinberger (2004, 5).

6 Rheinberger's ideas have been significantly influenced by the writings of Jacques Derrida (he translated *De la grammatologie* into German) and Gilles Deleuze.

what we do not yet know. This openness and room for not-knowing, or not-yet-knowing, cannot be imposed by stern methodological procedures. As Rheinberger points out, serendipity, intuition, and improvisation are at least as important in laboratory practice as the attempts that are made to stabilise the technical conditions in which experiments take place. That openness also implies "a kind of *subsidiary awareness* that may serve to mitigate the classical notion of dualism of thinking and being (though not entirely transcending it) as a borderline case in a relativistic epistemology" (Rheinberger 2005, 72, my translation, italics added). By "subsidiary awareness" (*nicht-fokale Aufmerksamkeit*) Rheinberger, commenting on Michael Polanyi,[7] is referring to a form of thinking that is obliquely based on tacit knowledge, on implicit understanding that is partly sedimented in the technical apparatus of the experimental system. This form of awareness, Rheinberger says, "would enable us to let our thinking blend into the things, and the things into our thinking, with hybrid forms in the middle that allow neither formalisation nor quantification, and which thereby keep the research moving" (ibid., 72, my translation).[8] Epistemic things are precisely these hybrid forms in which thinking and things are interwoven.

ARTISTIC EXPERIMENTS

As I have pointed out elsewhere (Borgdorff 2011, 52–53), an artistic experiment cannot be simply equated with a scientific experiment. In fact, it would often appear that two different meanings of the word "experiment" are being employed. In an essay entitled "Kunst als epistemische Praxis" (Art as Epistemic Practice), Dieter Mersch (2009) has attempted to draw a clear distinction between artistic and scientific experiments. Making reference to artists such as John Cage, Karlheinz Stockhausen, and Joseph Beuys, he argues that artistic experiments are not reproducible, and are in fact usually at variance with such a requirement. Nor do they primarily seek to augment knowledge, but rather to engage in a specific form of "experimental reflexivity" that touches on the foundations of our perception (and not our understanding).

This and other descriptions of artistic experiments portray scientific experiments as method-driven, systematic, repeatable, and universalisable, as rational and causal activities. Yet as research by Rheinberger, Bruno Latour, Karin Knorr Cetina, and others has shown, ordinary laboratory practice, in the context of discovery, is far less method-based than this, and many attributes normally associated with artistic discovery—such as instability, indeterminacy,

7 "Forschung beruht auf wildem Denken, und wildes Denken setzt stummes Wissen voraus" (Rheinberger 2005, 62, my translation; Research relies on untamed thinking, and untamed thinking assumes tacit knowledge).

8 The full quotation in German is: "...eine Form nicht-fokaler Aufmerksamkeit, von der aus sich das klassische Konzept des Dualismus von Denken und Sein zwar nicht aufheben, aber vielleicht entschärfen lässt als ein erkenntnistheoretischer Grenzfall im Rahmen einer relativistischen Epistemologie. Diese würde es erlauben, das Denken in die Dingen übergehen zu lassen wie die Dinge ins Denken, mit hybriden Bildungen in der Mitte, die sich weder formalisieren noch quantifizieren lassen, und die gerade dadurch das Forschen in Gang halten."

serendipity, intuition, improvisation, and a measure of "fuzziness"—also apply to scientific laboratory experiments (Rheinberger 2005, 66). Cage's assertion that it is "simply an action the outcome of which is not foreseen" also describes the scientific experiment (Cage 1959, 69, quoted in Mersch 2009, 43). The similarities are striking, and they invite closer investigation, without automatically giving reason to equate scientific experiments with artistic ones.

The term "experimental system" could give the impression of a fixed structure, whose elements relate with one another in clearly ordered, stable arrangements. In using this term, however, Rheinberger does not have a systems theory in mind, such as that of the German sociologist Niklas Luhmann. He is simply highlighting a loose coherence between the various elements of the experimental system (technical, epistemic, social, institutional elements), in both a synchronic and a diachronic sense.[9] In the historical and philosophical literature on science, the interest in experimental systems arose at the point where the theory-dominated view of scientific research began to make way for ideas centring on practice (cf. Schatzki, Knorr Cetina, and von Savigny 2001; Rheinberger 2004, 2). Now practices generally manifest the same characteristics as Rheinberger's systems. Practices also show a certain coherence and persistence. The *Oxford English Dictionary* (2013) defines "practice" in one sense as "an established procedure or system." One can therefore just as well speak of "experimental practices" as of "experimental systems," not least because Rheinberger also applies his findings on experimental systems to academic practices outside the laboratory, such as interpretation in the humanities, and notably writing.[10] In the literature on the practice turn in thinking about science, practices are not regarded as mere routines guided by rules that are founded on well-ripened, if sometimes tacit, knowledge and skills. They are also recognised as dynamic, creative, constructive, and normative actions (Knorr Cetina 2001, 187; Rouse 2001, 189). In and through practices, knowledge comes into being. Scientific research is therefore anything but static; it is always "science in action" (Latour 1987).

In artistic practices, too, experience and expertise that have sedimented into tacit knowledge form a fertile ground for a dynamic, creative, and constructive process that enables the emergence of the new and the unforeseen. At the same time, artistic practices—even the most conceptual and the most transitory of them—are always technically and materially mediated (see also

9 In his online essay "Experimental Systems," Rheinberger (2004, 4–6) gives a more detailed description of such a system: (a) it is the smallest discrete working unit of research; (b) it must be capable of undergoing "series of differential reproductions"; (c) it is the entity "within which the material signifying units of knowledge are produced"; and (d) if experimental systems merge together or branch out, that can result in "ensembles of such systems, or experimental cultures."

10 "Das Schreiben, so behaupte ich, ist selbst ein Experimentalsystem. Es ist eine Versuchsanordnung. Es ist nicht nur ein Aufzeichnen von Daten, Tatbeständen oder Ideen. Es ist auch nicht einfach der billige Ersatz für die lebendige Rede. Es ist nicht einfach das transparente Medium der Gedanken. Es gibt ihnen eine materielle Verfassung und zwar eine, die das Entstehen von Neuem ermöglicht" (Rheinberger 2006b, 5, my translation; Writing, I would argue, is an experimental system in its own right. It is the set-up of an experiment. It is not merely the recording of data, facts, or ideas. Nor is it just a cheap substitute for the spoken word. It is not simply the transparent medium of thoughts. It gives them a material substance, and specifically one that enables something new to emerge).

Borgdorff 2011, 52). Such artistic practices constitute the centre and the motor of research in the arts, just as experimental systems are the centre and motor of scientific research. This will now enable us to sharpen the focus of our question about the epistemological status of art within artistic research.

ART WORKS AS EPISTEMIC THINGS

An experimental system thus involves the realisation and articulation of epistemic things that derive their propelling force in the research from their very indeterminacy (we don't know exactly what we don't yet know [Rheinberger 2006b]). Similarly, within artistic practices, artworks are the hybrid objects, situations, or events—the epistemic things—that constitute the driving force in artistic research. To paraphrase Rheinberger (2010, 156), as long as artworks and their concepts remain vague, they generate a productive tension: in reaching out for the unknown, they become tools of research.[11] In the context of artistic research, artworks are the generators of that which we do not yet know. They thereby invite us to think. Artistic research is the articulation of this unfinished thinking.

It is a commonplace to argue that art transforms things and situations and robs them of their unproblematic status. Yet therein lies its epistemic potential. Artistic practices, like experimental systems, are "vehicles for materialising questions" (Rheinberger 2006a, 25/28). Knorr Cetina (2001, 181) ascribes to epistemic things the ability to infinitely unfold: "I want to characterize objects of knowledge ('epistemic objects') in terms of a lack in completeness of being that takes away much of the wholeness, solidity, and the thing-like character they have in our everyday conception." This fundamental incompleteness (Adorno would say "non-identity") points us towards an "unfolding ontology" (ibid., 182). Artworks as epistemic things can never become fully transparent, and it is this structural lack of completeness that is the fuel and the motor of a creative, constructive practice, in which meanings emerge and realities are constituted.

In the context of artistic research, artworks are epistemic things and events that have not yet been "understood" or "known"—or, to be sure, that resist any such epistemological grip. Art's knowledge potential lies partly in the tacit knowledge embodied within it and partly in its ability to continuously open new perspectives and unfold new realities. I have elsewhere described this "knowing" as pre-reflective and non-conceptual (Borgdorff 2011, 59–61). I would now like to characterise it, with Rheinberger, as *a productive not-yet-knowing* against the backdrop of an ever-receding knowledge horizon.

What is the reality of these epistemic things? What reality is being unfolded here? Rheinberger (1992, 69, my translation): "We might tentatively say that the 'epistemic thing' is to scientific activity what a 'statue' is to the art of sculpture, a 'picture' to the art of painting, a 'poem' to the art of poetry. It is the 'scientific

11 "As long as epistemic objects and their concepts remain blurred, they generate a productive tension: they reach out into the unknown and as a result they become research tools" (Rheinberger 2010, 156).

real' that is engendered by scientific activity."[12] Research in the arts, then, articulates the "artistic real" as engendered by art practices. In some sense, this artistic real is more real than our everyday reality.[13] And this is exactly where the importance and the urgency of research in the arts lies. The artistic real is an *engendered* reality—a *factum*, something that has been made, not a *datum*, something that was given beforehand (Rheinberger 2008, 22:36). An artistic "fact," like a scientific, social, or historical fact, is what we make real with our epistemological undertakings.

This does not mean that we must lapse into some kind of relativism, idealism, or crude constructivism: "Experimental scientists," writes Rheinberger (and I argue that this also applies to artists), "do not read the book of nature, they do not depict reality. But they do not construct reality either. They are not engaged in platonistic exercises, in asymptotic approximations to an always presupposed essence of reality, or in bluntly social constructivist endeavours" (2006a, 282, my translation; cf. English version, 225). The dynamics of both artistic and scientific research lies in the dialectics of revelation and constitution. Artistic and scientific research is about something real, while simultaneously transforming it into what it could be.

The fundamental incompleteness or non-identity of artworks as epistemic things—of art as research—creates room for what is unthought and unexpected. "The endless game of realization of the possibles" (Rheinberger 2006a, 283/225) invites us to dwell at the frontier of what is, and of what we know or can know. The condition of art as research is a condition of contingency. The openness of art is what invites us, again and again, to see things differently.

"research" and "publication"

At the working meeting entitled "Exposing Practice" (Zurich, 17 June 2011), Hans-Jörg Rheinberger (2011), in response to the discussion about the meaning of the term "artistic research," drew a distinction between the epistemic and the artistic. Traditionally—that is, in the history of the sciences—the term "research" has been applied to the domain of the scientific and the epistemic, and not to that of the artistic or the arts. The term "artistic research" would

12 "Man könnte versuchsweise sagen, das 'epistemische Ding' sei für die wissenschaftliche Tätigkeit das Äquivalent zur 'Skulptur' für die Bildhauerei, zum 'Bild' für die Malerei, oder zum 'Gedicht' für die Poesie. Es ist das in der wissenschaftlichen Aktivität hervorgebrachte 'Wissenschaftswirkliche.'" Rheinberger has adopted the term "scientific real" from Gaston Bachelard.

13 "The particular reality of the scientific real is ... its capacity to drive beyond itself, to give space to unprecedented events. It is exactly in this sense that experimental arrangements are, in a way, 'more real' than our good everyday reality. The reality of an epistemic thing explored within an experimental system resides in its resistance, its resilience, its capacity, as a joker and obstacle of practice, to turn around our previsions as well as our imprevisions, in a word, to give birth to unprecedented events" (Rheinberger 2004, 8). Cf. my own observations (Borgdorff 2011, 60): "When we listen to music, look at images, or identify with body movements, we are brought into touch with a reality that precedes any re-presentation in the space of the conceptual. That is the abstractness of all art, even after the long farewell to the aesthetics of early Romanticism. In a certain sense, this reality is more real, and nearer to us, than the reality we try to approach with our epistemological projects. This is the concreteness of all art, even in its most abstract forms and contents."

seem to conflate the epistemic interest and the artistic interest. Christoph Hoffmann added that "knowledge" should be understood as propositional knowledge, and as such it is tied to epistemological standards and cannot simply be merged with conviction, belief, or aesthetic experience. I have sufficiently treated the latter issue elsewhere (Borgdorff 2011).

At the same time, Rheinberger saw potential for linking the epistemic to the artistic (or the aesthetic). He cautioned against making the distinction between the epistemic and the aesthetic too sharp, as there are gradations, intermediate forms. There could also be mutually incompatible extremes, but in a chain of interactions à la Latour these might eventually be brought together. It may therefore be insufficient to think about the sciences without aspects of the artistic. And, on the other hand, in thinking about the arts one would also consider the epistemic.[14]

Rheinberger was right, of course, to point out that the term "research" is historically associated with the domain of the sciences (although it is also used in other contexts). As for the epistemic, however, there are also historical ties with the artistic, in particular in the tradition of philosophical aesthetics. Moreover, it is quite possible, though perhaps not very common, that the meaning of certain words changes because their usage changes, either now or in the future. Often, in fact, the very history of what is denoted by those words, or at least our interpretation of that history, may change.

A second issue addressed at the meeting was what the word "publication" might mean in the context of artistic research. Hoffmann drew a clear distinction here between research and publication—in other words, between the context of discovery and the context of justification. Scientific and academic publications, including those in the humanities, according to Hoffmann, always involve the presentation of the ultimate findings or results, in the sense of produced facts, which stand at the end of a possibly lengthy research chain.

Ultimate findings, however, can only be conceived of at the extreme—as unreachable limiting cases or as regulative ideas or ideals—for no ultimate research results actually exist, just as no ultimate foundation exists for our knowledge claims. In this sense, every produced and justified fact is a tentative fact, and therefore always part of a continuing discovery, part of a science that is transforming itself.

Contemporary theory of science (and science and technology studies in particular) shows us that it is untenable, and not even defensible, to maintain a strict separation between the context of discovery and the context of justification (and between values and facts). Publications are not terminal stations in a scientific quest; they are always tentative representations of what is surmised. This basically open nature of "publications" is not a shortcoming that we have to live with, rather—in the case of artistic research—it is the starting point. Publications in the sphere of artistic research are better understood as contributions to a discursive field that is constantly in motion. As epistemic things, artworks not only play a constitutive role in a process of discovery that

14 Based on an audio recording of the working meeting (Rheinberger 2011).

eventually culminates in produced and justified facts. They are not just generators of knowledge. They are also (and I differ here with Rheinberger's view) that which is generated. This alliance of constitution and realisation, of discovery and justification, may be called, with Latour (1999, 135), *constructivist realism*.

REFERENCES

Biggs, Michael, and Henrik Karlsson, eds. 2011. *The Routledge Companion to Research in the Arts*. London: Routledge.

Borgdorff, Henk. 2011. "The Production of Knowledge in Artistic Research." In Biggs and Karlsson 2011, 44–63.

Cage, John. 1959. "History of Experimental Music in the United States." In *Silence: Lectures and Writings*, 1961, 67–75. Middletown, CT: Wesleyan University Press.

Knorr Cetina, Karin. 1999. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, MA: Harvard University Press.

———. 2001. "Objectual Practice." In Schatzki, Knorr Cetina, and von Savigny 2001, 175–88.

Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, MA: Harvard University Press.

———. 1999. *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, MA: Harvard University Press.

Latour, Bruno, and Steven Woolgar. (1979) 1986. *Laboratory Life: The Construction of Scientific Facts*. Princeton, NJ: Princeton University Press.

Mersch, Dieter. 2009. "Kunst als epistemische Praxis." In *Kunst des Forschens: Praxis eines ästhetischen Denkens*, edited by Elke Bippus, 27–47. Zurich: Diaphanes.

Noë, Alva. 2004. *Action in Perception*. Cambridge, MA: MIT Press.

Nowotny, Helga. 2010. Foreword to Biggs and Karlsson 2011, xvii–xxvi.

Oxford English Dictionary. 2013. "Practice, n." In *Oxford English Dictionary*, 3rd ed., online version, March. Accessed 31 May 2013. http://www.oed.com.ezproxy.ub.gu.se/view/Entry/149226?rskey=bzjlVy&result=1&isAdvanced=false.

Rheinberger, Hans-Jörg. 1992. *Experiment, Differenz, Schrift: Zur Geschichte epistemischer Dinge*. Marburg an der Lahn: Basilisken-Presse.

———. 2004. "Experimental Systems: Entry Encyclopedia for the History of the Life Sciences." *The Virtual Laboratory: Essays and Resources on the Experimentalization of Life*, Max Planck Institute for the History of Science, Berlin. Accessed 5 January 2012. http://vlp.mpiwg-berlin.mpg.de/essays/data/enc19?p=1.

———. 2005. *Iterationen*. Berlin: Merve Verlag.

———. 2006a. *Experimentalsysteme und epistemische Dinge: Eine Geschichte der Proteinsynthese im Reagenzglas*. Frankfurt am Main: Suhrkamp. First published 1997 as *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube* (Stanford, CA: Stanford University Press). Dual page references in the text refer respectively to the German and English versions (which may slightly differ).

———. 2006b. "Über die Kunst, das Unbekannte zu erforschen." Cogito Foundation. Accessed 5 January 2012. http://www.cogitofoundation.ch/pdf/2006/061025DieKunst_dasUnbekannte.pdf. Also published as "Man weiss nicht genau, was man nicht weiss: Über die Kunst, das Unbekannte zu erforschen." *Neue Zürcher Zeitung*, 5 May 2007. Accessed 5 January 2012. http://www.nzz.ch/aktuell/startseite/articleELG88-1.354487.

———. 2007. *Historische Epistemologie zur Einführung*. Hamburg: Junius. Translated by David Fernbach as *On Historicizing Epistemology: An Essay* (Stanford, CA: Stanford University Press, 2010).

———. 2008. "Epistemische Dinge—technische Dinge." Filmed 2 July, Bochum Media Science Colloquium. Vimeo video, 58:57. Accessed 5 January 2012. http://vimeo.com/2351486.

———. 2010. *An Epistemology of the Concrete: Twentieth-Century Histories of Life*. Durham, NC: Duke University Press.

First published 2006 as *Epistemologie des Konkreten* (Frankfurt am Main: Suhrkamp).

———. 2011. Audio recording of the working meeting "Exposing Practice" with Hans-Jörg Rheinberger, Zurich University of the Arts, 17 June. Private collection.

Rouse, Joseph. 2001. "Two Concepts of Practices." In Schatzki, Knorr Cetina, and von Savigny 2001, 189–98.

Schatzki, Theodore R., Karin Knorr Cetina, and Eike von Savigny, eds. 2001. *The Practice Turn in Contemporary Theory*. London: Routledge.

Shapin, Steven, and Simon Schaffer. 1985. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.

Artistic Experiments as Research

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The German lexicon *Aesthetische Grundbegriffe* (Barck et al. 2000–2005)[1] gives exhaustive definitions of a range of topics, but "experiment" is not among them. It is similarly absent from the general reference book *Kunstlexikon des 20. Jahrhunderts* (Thomas 2006). Nevertheless, experimentation in the arts is a theme that recurs constantly, and works by a multitude of artists have been described as experimental.[2] From Scholasticism to the Renaissance, "experiment" was used in the same sense as "experience" (see Frey 1972, 2:868–70). Then, with the beginning of the modern era, experimental artistic representations came under suspicion because they implied perceptual trickery and sensationalism, as Barbara Stafford showed in her study *Artful Science* (1994):

> Any fine art that purported to demonstrate something—if only how to hold a puppy—and any scientific experiment sustained by machinery—no matter how obvious the technique—was liable to the accusation of *trompe-l'oeil* and pandering to spectatorial desire. (Stafford 1994, 134)

> The etiquette of observation and experiment, the body tricks of public science performers, the spectacle of automated toys, and the pantomime of businessmen's gestures belonged to a creative world of entrepreneurial promotion lying beyond the *Encyclopédie* and outside the walls of learned academies both in England and France. For inventors, whether in the visual arts or in natural philosophy, the exhibition of thought occurred in terms of concrete demonstrations and "mechanical representations." (ibid., 138)

In modern art, to focus on a more narrow time-frame, the adjective "experimental" is usually used when artistic methods and practices break away from established formal languages, thereby distancing themselves from tradition. In this sense experiments are defined through "novelty, trial, and moments of surprise" (Kreuzer 2012b, 7, my translation). At a first glance this appears diametrically opposed to our conventional understanding of scientific experimentation, which is associated with notions such as reproducibility,

1 See Dekadent–Grotesk in volume two of Barck et al. (2000–2005).
2 See for example Douglas (1975); Schmidt (1978); Rodtschenko (1993); Molderings (2006); Mainberger (2010); Kreuzer (2012a).

control, and measurability—although Ian Hacking (1999, 71) pointed out the experiment's independent existence when he wrote "Typically, the apparatus does not behave as expected. The world *resists*."[3] Therefore, he also pointed to the unforeseeable experimental dynamics that bring the intentional and unintentional inextricably together.

Experiment in the arts thus focuses on the media of production and representation; that is, aesthetic practices are explored though the very instruments or technologies themselves. The means and objects of experimentation are colours, forms, conventions, techniques, and technologies. This is not merely a matter of material examination—the "reflected handling of the respective specific visual, auditive, compository, technical, and material means" (Kreuzer 2012b, 8, my translation);[4] experimentation brings into question the relations between different representational techniques, respectively methods and expressions.

Because artistic experiments act with and through aesthetic practices—that is, through practices of sensual representation concerned with perception, I will hereafter equate artistic experiments with aesthetic ones. Moreover, by means of this expanded definition, I refer to debates among numerous philosophers about a specific way of aesthetic thinking that is contrasted with a scientific kind of thinking committed to the primacy of reason and logic even when oriented towards artistic models.[5] Aesthetic thinking can be described as polyvalent, heterogeneous, and experimental, encompassing inconsistencies, incommensurabilities, and contradictions, and embracing incompleteness, just as artistic practice does.[6] It is realised by experimental representations and with the help of instruments and devices. It makes possible the formulation of alternatives to the experimental method of science and to purely cognitive processes. Aesthetic thinking, described this way, is much indebted to criticisms of modernity and its guiding concepts: logocentrism, anthropocentrism, monosemy, and visual primacy.

Much of this kind of thinking can be applied to art in general, but there are good reasons to refine its characterisation, especially for artists doing research in a social-cultural field or in conceptual art. On the one hand, "aesthetics," particularly since the eighteenth century, is often understood to be a universal term that is complementary to or contrasted with science. On the other hand, the nature of an artistic experiment, as framed in the debate on aesthetic thinking, implies that the result of the experimental process surprises the person who conducted it (Steiner 2006, 24).[7] In the context of art, this leads to a mystification of the artistic process and the artist: the artistic

3 See also Steiner (2006, 25).

4 For some time such blends of (experimental) research in the field of (cultural) science, which exceed the boundaries of disciplinary juxtaposition and expand possibilities of action and thought, have attracted interest. *Lecture Performances* should be pointed out as exemplary in this regard, as they are experimental forms of presentation between art and science. Cf. the Giessen Award for Scholarly Presentation and Lecture Performance, on which see Gießener Preis für wissenschaftliche Präsentation und Lecture Performance (2011).

5 See Lyotard (1986, 51–77); Welsch (1990).

6 For the following statements, cf. Steiner (2006, 18–23).

7 This matter is criticised by Steiner in regard to Lyotard and Welsch.

process is decontextualised, left unrelated to rules or historical contexts, and thus appears to be a process arising from "genius."

But artistic processes aren't actually completely different from processes in science or the humanities. Indeed, unpredictability in the outcome of an experiment characterises scientific as well as artistic practices. To return to the linguist and theorist of science Ian Hacking (1999, 71): "Typically, the apparatus does not behave as expected. The world *resists*. Scientists who do not simply quit have to *accommodate* themselves to that resistance. They can do it in numerous ways. Correct the major theory under investigation. Revise beliefs about how the apparatus works. Modify the apparatus itself. The end product is a robust fit between all these elements." Now if the artistic experiment virtually relies on resistance, instead of adjusting to it as in science, it does so not merely to be surprised and overwhelmed by unpredictability but rather to reveal possible ways to experience and think about the world and about life, in the interplay of aesthetic practices and the resistance of the media and the apparatus, etc. It is exactly this purpose that often requires a controlled procedure. Thus, the artistic experiment, as a discipline, is not confined to practice alone; rather it includes an inherently epistemic dimension. For the same reason, it also welcomes resistance, since this enables a potential to search for fractures and to oppose techniques that generate unity in favour of a sustainable search for arrangements, constellations, and formations. It initiates processes that can lead to precise, singular artistic practices, aiming at specific rather than generalised experiences.

One could say that an experiment is to be characterised as artistic when it brings forth exactly Hacking's resistance of the world (see above), a resistance upon which science attempts to force conformity by means of "objectivity" (Daston and Galison 2007) and especially under the "conditions laid down for visibility... [and] within the conditions relating to statements" (Deleuze 1988, 59). But artistic experiment is not just open to resistance and its potentials; it actively seeks them out. When Francis Bacon in 1620 wrote "There remains mere experience: which is chance, if it comes by itself; experiment, if sought" (Bacon 2000, 67) he had in mind the scientific sense of "experiment," which implies a planned set of observations only feasible at a specified time and under controlled conditions.

Bacon's statement could easily have originated, however, from the famous artist with the same name, a painter who was born more than three centuries later and whose artistic practice was primarily focused on the human body. This Francis Bacon attempted, according to Gilles Deleuze, to free himself from conventional, historical, or socially determined structures of belief using apparently "asignificant," involuntary, casual, free, and desultory paint strokes, through which the unexpected emerges (see Deleuze 1995, 63). Not waiting for chance to ensure success, he experimented with diagrams—that is to say, with the operative events of lines, strokes, and stains. The diagram is, as Deleuze says, a kind of chaos that both prevents an optical organisation of the painting and provides a seed for order and rhythm. The artistic experiment therefore consists of representation supported by diagrammatic adjustments of lines

and spots: an attempt to approximate the catastrophic in order to disassociate the representation from the known without plunging it into chaos (ibid.).

Even disregarding the post-1960 migration of experimental art from strict studio spaces and towards the world of life and the viewer, which raises questions about artistic experiments in an expanded system, an artistic experiment generates something new that imparts itself to our senses. It elicits an experience from which one emerges changed. Art and especially artistic research are thus challenged to identify the change produced by a singular experimental experience and to make it into an object of knowledge. However, uniqueness and inimitableness, and also the perceptions and experiences that follow from such singular events, are all usually considered accidental and contingent and therefore epistemically redundant.[8]

Usually two instances of translation take effect here: on the one hand, art criticism, art history, art philosophy, and art education provide for an opportunity of discourse regarding the singular, by contextualising it, that is, by linking it to methods of production, theories, or historical circumstances. But on the other hand, artists have taken up the challenge of translation as well.

THE CONCEPT OF THE EXPERIMENT IN RELATION TO TRADITION AND CONCEPTUAL ART

Marcel Duchamp plays a pivotal role in this context, as he refrains from reducing the experimental event to the production of a singular work of art that is an autonomous, purely visual phenomenon. Rather, he views the image as a functional, epistemic object, a view that was moulded by natural science, as Herbert Molderings points out in his study *Kunst als Experiment* (2006, 10) (translated as *Duchamp and the Aesthetics of Chance* [2010, xiv]). The artist is no longer understood to be a "creator of paintings," but rather to be an inventor "of experimental setups in which 'images' are both the instruments and the results of an experiment" (Molderings 2010, xiv). With his *3 Stoppages etalon*, Marcel Duchamp founded "a new style in the art of the twentieth century, one of experimental visual thinking" (ibid.). This style, in which art practice is seen from different perspectives as representing intellectual action in the material itself, transforms the concept of pure practice by merely focusing on physical aspects. Duchamp made no secret of his intention to give the new art a scientific foundation; he wanted to introduce to art the exactness and precision of science. But this was not only a matter of adjusting art to science; it was equally about deconstructing simplistic and clichéd ideas about art and science in a strategically humorous and ironical play. He did not conduct absurd experiments according to scientific standards "for love of science… on the contrary, it was rather in order to discredit it, mildly, lightly, unimportantly. But irony was present" (Duchamp in Cabanne 1971, 39).[9]

8 Concerning the question of the singular and aesthetics, see Schaub (2010).

9 Duchamp thought about hypothetical, merely thinkable phenomena, which he intended to visualise. His object of interest centred on the thinkable and it was just that which distinguished his activity as

In the 1960s conceptual art problematised further the idea that art was pure practice, uniquely constituted by each artist. It thus confounded prevailing descriptions of abstract expressionism, which was celebrated as the embodiment of independence and spontaneity, free of all restrictions and conditions, despite its often calculated painting techniques. Artists Ian Burn and Mel Ramsden, who belong to the Art & Language group, summarise the inherent limitations of artistic practice thus: "Under the results of practical art it became evident to many of those whom I should now describe as analytical artists that one could only vary one's artistic conduct insofar as one stuck to 'normal' changes in the appearance of an art-work, and this, only after swallowing *in toto* a set of tacitly agreed upon conventions. Thus the role of artistic conduct was restricted by 'practice' to myriad, though tedious, morphologies" (Burn and Ramsden 1974, 96). From these artists' point of view, individuation in art follows from conventions and contexts; it in no way results from "any 'magical' thing [artists] could put 'in' that work itself—which held the reasons for individuation" (ibid., 96, 98). Consequently, they seek to explore systematically the complex of regulations that govern practice and to gain awareness of its operation. By objectifying the context, the norms, and the historical categories of art, they endeavour to bring about change through "treating the context or category itself, of changing and expanding this context to take in new modes of conduct outside of a strict notion of practice—possibly expanding it until it can take in some notion of theory" (ibid., 98). Their activity is not limited to the object, the work of art, processes of perception and practice—that is, to those properties that, highly standardised and regulated by conventions, were considered to be fundamental to singular artistic acts. Rather, their focus shifts to the function of art.

Through its history, conceptual art has challenged mystification. Marcel Duchamp links experimental processes with visual-material activities and thought processes, and he confers the medial value[10] of the epistemic object to the work of art. Conducting absurd experiments, Duchamp plays with the unpredictability of repetitive events. Conceptual art reflects the institutional and conventional frames for artistic action, exposing the pretence of immediate practice as a naive misapplication of standard, normalised conventions. In so doing, conceptual art defends the unpredictable itself from the threat of standardised processes. From the twentieth century to the present, faith in the purely individual relationship between the artist and his or her material and in the independence of art created in the studio has been strongly shaken. Artistic production—even by would-be "geniuses"— turns out to be a strategic activity that occurs within a medial, spatial, and temporal fabric pervaded by desires, projections, affections, and power dynamics. Alternatively, they prove to be experimental activities, as in Paul Cézanne's series *Mont Sainte-Victoire* or

genuinely aesthetic, for his productions aim at what is possible, not at the creation of theories.

10 Here I use the expression "medial value" in the sense of current media theory: the entity is neither the object of consideration nor its instrument; it is a medium. Therefore, it forms a constructive part of reality. Media render possible different forms of subjectivation, of construction, and of ways to access reality.

in early video works by Bruce Nauman. The possible meanings of a work of art thus arise not from the "fantastic appearance it may display" but from "its special role within the art-context" (Burn and Ramsden 1974, 100) and its experimental procedures and techniques.

EXPERIMENTAL SET-UPS AFTER STUDIO PRAXIS

Such challenges to the visual-material way of thinking, to institutional framings and standardisations and even to the historical-societal distinctions between, for example, art and science find their expression in practices characterised by site specificity or institutional criticism—more generally, in post-studio practices. When the artistic experiment is no longer reduced to a relationship between artist and material, the studio turns into the modern laboratory that Peter Galison (2001, 97) metaphorically characterised as a "networked web" in Hans-Ulrich Obrist's exhibition catalogue *Laboratorium*.[11] Such a laboratory is in a constant state of flux, variously shaped and ever in transformation. Laboratories understood as networked webs "[join] local skills and practices with distant ones, combining earlier goals with new ones" (Galison 2001, 107). They "move precisely by establishing new material pidgins and creoles, by finding new ways to recombine procedures of work" (ibid.).

Galison's characterisation of the modern laboratory also applies to experiments in art, because the studio is no longer merely an interface between the private and the public, a space in which works of art are made accessible to the art community. The studio is, rather, pervaded by the structures of the art system. The artist is now an "exhibition artist" (Bätschmann 1997, my translation; Ausstellungskünstler), the experiments in the studio have been infected by the other, the external. Hybridised artistic methods or themes, whether sought consciously or found unconsciously, emerge in tandem with the already known material, institutional, and historical-societal aspects of artistic experimentation. As early as 1929, in his essay "Lebendiges Museum," Sigfried Giedion (1929, 103, my translation) called for an "experimental laboratory" to be set up in every public institution, a laboratory that would be a "department giving a voice to all art forms currently under discussion." With this, Giedion (ibid.) turned against musealisation of art in favour of a "living chronicle of time." Art is not an object of knowledge concerned with designing and representing; it is a kind of knowledge practiced in a sensuous reality. By placing the presentation of art in an experimental laboratory, Giedion asserts that knowledge linked with art is not elucidated by experts; rather, the beholder turns into an "emancipated spectator" (Rancière 2008).

The cultural appropriation of the term "laboratory" is also revealing in that its metaphoric function is to force open traditional perceptions or concepts of art

11 For Galison (2001, 97), the "laboratory [is], at different times, a chamber of magic, a parliament, a home, a cottage industry, a factory, a monastery, a networked web. And in analyzing this shifting identity, we must somehow maintain a dual vision about its relation to the broader world—the laboratory-as-mirror and the laboratory-as-blueprint."

and its function. An exhibition attempts to identify the societal importance of art for a beholder by refraining from ascribing any representative function to it, instead invoking a participative reception that allows it to become a medium/instrument of a kind of visual thinking and social practice, enabling an actual diagnosis of the present. In art schools "the laboratory" serves to facilitate collaborative rather than individual methods of studio practice (see Lab.D 2013).

Artistic experiments today, as discussed above, are associated with reflections on the conditions of visual material and their institutional-historical framing and standardisation. Together these determine the range of the experiment, which can occur in individual as well as collaborative practices. In practices which are post-studio or which have shifted focus from classical production to presentation and communication, artistic experiments are not limited to productions by artists within a confined artistic domain; rather, they enable a kind of participation that extends the production beyond the object and beyond the discourse that surrounds immanent art.[12] In an openly experimental, hybrid array situated in a networked-web-like laboratory, artistic experiments do not seek to generate general theories. They explore inferences and possibilities by ironically and in an analytical or critical way undermining systems of regulation from within. Marcel Duchamp and conceptual art demonstrate this. From this perspective Duchamp was not content with the liberties available in art when viewed as opposed or complementary to science. By blending scientific and aesthetic logic he rejected both science's veneration of objectivity and truth and art's veneration of the individual (see Molderings 2006, 54). He questioned the very distinction between art and science. Similarly, the inception of Art & Language may

> be regarded as a symptom of a complex re-evaluation of conventional categories of art and artistry—a process, in which language received both a pragmatic-materialistic and fictionalising-immaterialising function... The epistemological publishing practice of the group was connected with a re-conception of pedagogic practice. The model intended by *Art & Language* wanted to be nothing but a radical alternative to the patterns of professionalisation and career modelled on artists' individual success, which are so dominant in the art world and which reflect existing class relations. (Buchmann and Holert 2010, 194, my translation)

Duchamp and conceptual art are paradigmatic instances of an artistic-experimental mode of thinking/action that rejects the claims of justification that have been common in Western aesthetics. From an epistemic and aesthetic point of view, artistic experiments are fundamentally antifundamental (Früchtl 2010, 126) and critical of rationality and prevailing knowledge cultures.

12 See Bippus (2012), in particular the paragraph "Das Ausstellungs-Display als Laboratorium" starting on page 115.

ART AND SCIENCE AS EXPERIMENTAL SYSTEMS

Marcel Duchamp and conceptual art and other art movements integrated scientific procedures, methods, and problems into the domain of art. Conversely, for some years now science has acquired artistic terms and methods that allow new ways to describe processes. For instance, when Hans-Jörg Rheinberger compares the experimental system of science, the laboratory, with the studio, he calls into question our sense that the scientific experiment is a methodically ordered procedure. He undermines the distinction between scientific experiments, conceived as reproducible, verifiable events used to systematically record phenomena and detect physical laws,[13] and artistic experiments, conceived as unsure, daring, and risky enterprises with uncertain or even incomplete outcomes; for him experiments in science are also precarious events. "Experiment" comes to connote attempt and adventure, and connotations of replication and verification are disavowed. Accordingly, Rheinberger recognises that an experimental system must be open to uncertain searches, hesitations, and moments in which "the course has not yet been set, and action may take place in the unknown" (Rheinberger 2005b, 79, my translation). Indeed, the unpredictable is described as essential to the effort "to capture what is not devisable" (Rheinberger 2007, 84). According to Rheinberger, researchers create their own empirical structure within an experiment, an environment that allows for movement across the border between knowledge and ignorance to gain a new, unpredictable kind of knowledge. Thus, as the new emerges from the experimental system, the researcher captures it, without any possibility of anticipation or construction whatsoever.

Rheinberger ascribes basic epistemic and historical consequences to the experimental system, "the smallest integral working unit of research" (Rheinberger 1997, 28). On the one hand, the choice of the system "determines the experimenter's realm of action, the range of questions he can ask, and the kind of answers he can get" (Rheinberger 1992, 22, my translation). On the other hand, the research process is freed from the strictures of theory. Quite the contrary: "a movement regulated by boundaries that are instrumentally conditioned" drags "reasoning into the game of material entities" (ibid.).

Under the conception of scientific "objectivity," as developed in the eighteenth century, affirming the process-focused obstinacy of an experimental system and its instrumental conditions would have inevitably negated its scientific legitimacy, which depended exactly on apparatuses to ensure repeatable and controllable processes free of any subjective or aesthetic intervention. Today's scientists are apparently characterised by their "epistemic complicity" with the system and its obstinacy. As Rheinberger explained at the "Experimental Aesthetic" conference, an experimenter's virtuosity consists in his capability to perceive events that are expected to occur at the border of the discourse

13 Recall the principles set forth in 1935 by Karl Popper in *The Logic of Scientific Discovery*: "Only when certain events recur in accordance with rules or regularities, as is the case with repeatable experiments, can our observations be tested—in principle—by anyone... Only by such repetitions can we convince ourselves that we are not dealing with a mere isolated 'coincidence,' but with events which, on account of their regularity and reproducibility, are in principle inter-subjectively testable" (Popper [1959] 2002, 23).

"precisely because he confidently interacts with the system" (Rheinberger 2011, 18, my translation).[14] By building analogies between scientist and artist, both working in darkness "and being led by the tunnels and shafts of previous works" (Rheinberger 2006, 1, my translation), their activities seem interchangeable. Interestingly, Rheinberger effects the convergence of both practices with a description of the artist by the art critic George Kubler.

Indeed, the boundary between art and science is becoming increasingly uncertain, in that in both domains the material conditions and their production have been shown to play a significant role in the formation of knowledge. For the generation of epistemic things crucially depends on technological conditions, differential reproductions of experimental systems, conjunctions of such systems, and graphematic representations (see Rheinberger 2005a, 24). In *Iterationen* (2005a), Rheinberger characterises scientific activity as a play of writing and of laying tracks. To play productively, "experience" is required from the experimenter, something that "can perhaps be best paraphrased using the paradoxical expression 'acquired intuition'" (Rheinberger 2012, 94). For scientific purposes, the "play of possibilities" or the "play of differences" is crucial; and with the "play of difference" Rheinberger alludes to Jacques Derrida,[15] linking his thought to methods used in (natural) science. Moreover, by proposing that laboratory practice encompasses movement without any ultimate meaning, Rheinberger (2005a, 25) invokes the descriptive modalities used for literary works. He introduces the term "xenotext" (ibid.) developed by Brian Rotman (1987) and applied to avant-garde texts. "Xenotext" means "alien text"; for Rheinberger, an "other text" is characterised "by its ability to bring readings of itself into being" (Rheinberger 2005a, 25, my translation). It has no "ultimate 'meaning,' no single, canonical, definite, or final 'interpretation'" (ibid.). Rather, its importance rests in its potential to become what Rheinberger, borrowing from François Jacob, refers to as a "machine for making the future" (ibid.).

Rheinberger's characterisation of laboratory activity brings together artistic and scientific practices in that both create possibilities, with the resulting phenomena being machines—visual-material future-generators that make possible the interpretation, design, and production of the future. Both practices play with the possible. The epistemic consequence of the play is an unavoidable deferral: "There is no other way of getting hold of them than by an inevitable temporal delay. Thus, the artist, just like the scientist, cannot know what he is doing since he is 'inside' his actions" (ibid., 26). Events that happen in the constellation of an experimental system have no meaning at the moment of their formation. They gain meaning in their interpretive future.[16]

Historically, the indeterminacy of art's meaning, which may now be described as its potential to generate a future, was attributed to aesthetic qualities and

14 See also Bernardy, Fitzner, and Haarmann (2012).

15 Rheinberger translated Derrida's landmark work *De la grammatologie* (1967) into German with Hanns Zischler. The French philosopher unfolds his concept of difference in the text "La différance" (Derrida, 1972).

16 Deferred actions allow Rheinberger (2005a, 27, my translation) to describe the entire history of science as futile, "anticipating the unheard (Unerhörte) by perpetrating it."

contributed to the glorification of artists as geniuses and to the sacralisation of their experimental potency. Duchamp and conceptual art represent a paradigmatic change, in that both assert that in artistic experiments indeterminacy, or "the play of the possible," takes place within material, institutional, and historical-societal contexts. Following Mirjam Schaub's (2010, 14) line of thought, it can be said that it was singularity in particular—and sensuality to a much lesser extent—that separated aesthetics from questions of knowledge. The singularity of the artistic experiment should therefore be considered especially with regard to its knowledge potential. Continuous and critical self-reflection on conditions, framings, and localisations of the art system are necessary to retain this singularity and keep open the play of the possible. Moreover, the play of difference gains importance as a strategic game: knowing and mastering the rules of the system is essential, not only to be able to play with them confidently but also to emancipate oneself from them.

When experimental practice is viewed as comparable in art and science, the sensual knowledge intrinsic to artistic or aesthetic research is no longer a disruptive factor that needs to be excluded. Research can then be understood more broadly, as an exploratory attitude towards the world, an activity that investigates things but also, very importantly, brings into play manifold possibilities, rendering them negotiable. Knowledge then becomes particular and concrete. In *An Epistemology of the Concrete* (2010), Rheinberger asserts that the differences between the humanities and natural sciences resulted from historical and institutional conditions and asks why we continue to insist on this cultural differentiation:

> The scientific disciplines, which had emerged roughly in their present form by the end of the nineteenth century, were in their turn ultimately only institutional expressions of this fundamental process of the production of different scientific objects.
> The primordial dichotomy of nature and culture inscribed in the division between the natural sciences and the humanities has been challenged ever since. Is there any reason to hold fast to this stubborn, yet central difference? ... For under twentieth-century conditions, historical epistemology can presuppose neither a fundamental unity nor a fundamental disunity of the sciences; it must rather come to grips with a displacement of borders that occurs time and again as an effect of scientific thought and action itself, whose shape has become as malleable as the border between the natural and the human sciences. (Rheinberger 2010, 3–4)

As a historian of science, Rheinberger repudiates grand narratives of progress, instead emphasising the importance of examining "local histories with an eye to their implications for the historical long term, without sacrificing the richness of detail that is their strength" (ibid., 9).[17] Finally, he asserts: "assemblages—historical conjunctures—set the conditions for the emergence of epistemic novelty" (ibid., 10).

17 He narrates "the history of experiments, concepts, model organisms, instruments, and the whole gamut of institutional, political, and social factors that determine the actual course of the development of knowledge" (Rheinberger 2010, 10).

If it is truly obsolete to rely on general, timeless principles to ensure the acquisition of (scientific) knowledge, scientific knowledge should not be considered the sole method for present-day production of knowledge. I arrive at this conclusion: In the context of current debates on art and science, the artistic experiment is no longer just "the wild outside" of the scientific experiment; instead, the scientific experiment itself proves to be characterised by contingencies and emergences of unpredictabilities, affects, and material dynamics. Conversely, the artistic experiment can now be characterised by systematic repetition. Which future and what knowledge can be generated by the respective experiments depends on the contexts and even more on the discursive spheres in which they are negotiated.

All of these convergences of art and science, these disintegrations of dichotomies, lead with some urgency to the matter of "what *we*—considering the background of our knowledge and our objectives…—are prepared to reasonably acknowledge [as knowledge]" (Schnädelbach 2002, 85–86, my translation)[18] and what kind of presence, existence, and ways of life we thereby favour and allow to shape the play of the possible. In the end, the experiment—be it artistic or scientific—cannot be separated from the disposition of knowledge and its hierarchies. Efforts to open up knowledge production in an artistic experiment within the cultural sphere modify the disposition of knowledge that is shaped by the sciences. Artistic experiments challenge these not by binding themselves to artists' productions but instead by opening themselves to participation. Experimental systems of artistic research are thus freed from limitations, enabling heterogeneous and contradictory knowledge production. Knowledge generated in this manner may not conform to that generated by science; but then, "not all knowledge is scientific, which is a fortunate thing" (Stiegler 2011, 113, my translation).

18 Herbert Schnädelbach (2002, 85) brings up this question regarding scientific knowledge in the face of the industrialisation of science.

REFERENCES

Bacon, Francis. 2000. *The New Organon*. Edited by Lisa Jardine and Michael Silverthorne. Translated by Michael Silverthorne. Cambridge: Cambridge University Press. First published 1620 as *Novum Organum*.

Barck, Karlheinz, Martin Fontius, Dieter Schlenstedt, Burkhart Steinwachs, and Friedrich Wolfzettel, eds. 2000–2005. *Ästhetische Grundbegriffe: Historisches Wörterbuch in sieben Bänden*. 7 vols. Stuttgart: Metzler.

Bätschmann, Oskar. 1997. *Ausstellungskünstler: Kult and Karriere im modernen Kunstsystem*. Cologne: DuMont. Translated by Eileen Martin as *The Artist in the Modern World: A Conflict Between Market and Self-Expression* (New Haven, CT: Yale University Press, 1997).

Bernardy, Jörg, Werner Fitzner, and Anke Haarmann. 2012. "Experimentieren, um zu sehen: Zur Theorie und Praxis ästhetischen Experimentierens," review of "Experimentelle Ästhetik," VIII. Kongress der Deutschen Gesellschaft für Ästhetik, Kunstakademie Düsseldorf, 4–7 October 2011. *Journal of Literary Theory Online*. Accessed 24 April 2013. www.jltonline.de/index.php/conferences/article/view/440/1227.

Bippus, Elke. 2012. "Modellierungen ästhetischer Wissensproduktion in Laboratorien der Kunst." In Kunstforschung als ästhetische Wissenschaft: Beiträge zur transdisziplinären Hybridisierung von Wissenschaft und Kunst, edited by Martin Tröndle and Julia Warmers, 107–25. Bielefeld: Transcript.

Buchmann, Sabeth, and Tom Holert. 2010. "Materielle Praxis, Wissensproduktion: Kollektivität und Kollaborativität als Fluchtlinien des Künstlerischen." In ›Mit-Sein‹: Gemeinschaft—ontologische und politische Perspektivierungen, edited by Elke Bippus, Jörg Huber, and Dorothee Richter, 189–213. Zurich: Edition Voldemeer.

Burn, Ian, and Mel Ramsden. 1974. "Some Notes on Practice and Theory" / "Einige Bemerkungen über Praxis und Theorie." In *On Art: Artists' Writings on the Changed Notion of Art after 1965 / Über Kunst: Künstlertexte zum veränderten Kunstverständnis nach 1965*, edited by Gerd de Vries, 96–102 Cologne: DuMont.

Cabanne, Pierre. 1971. *Dialogues with Marcel Duchamp*. Translated by Ron Padgett. London: Thames and Hudson. First published 1967 as *Entretiens avec Marcel Duchamp* (Paris: Belfond).

Daston, Lorraine, and Peter Galison. 2007. *Objectivity*. New York: Zone Books.

Deleuze, Gilles. 1988. *Foucault*. Translated by Seán Hand. Minneapolis: University of Minnesota Press. First published 1986 with the same title (Paris: Éditions de Minuit).

———. 1995. "Das Diagramm." In *Francis Bacon—Logik der Sensation*, translated by Joseph Vogl, 62–68. Munich: Fink. First published 1981 as *Francis Bacon: Logique de la sensation* (Paris: Editions de la Différance). Translated by Daniel W. Smith as *Francis Bacon: The Logic of Sensation* (London: Continuum, 2003).

Derrida, Jacques. 1972. "La différance." In *Marge de la philosophie*, 1–29. Paris: Éditions de Minuit. Translated by Alan Bass as "Différance" in *Margins of Philosophy*, 1–28 (Chicago: University of Chicago Press, 1982).

Douglas, Davis. 1975. *Vom Experiment zur Idee: Die Kunst des 20. Jahrhunderts im Zeichen von Wissenschaft und Technologie: Analysen, Dokumente, Zukunftsperspektiven*. Translated by Wilhelm Höck. Cologne: DuMont. First published 1973 as *Art and the Future: A History/Prophecy of the Collaboration between Science, Technology, and Art* (New York: Praeger).

Frey, Gerhard. 1972. "Experiment." In vol. 2 of *Historisches Wörterbuch der Philosophie*, edited by Joachim Ritter and Karlfried Gründer, 868–70. Basel: Schwabe.

Früchtl, Josef. 2010. "Vom Nutzen des Ästhetischen für eine demokratische Kultur: Ein Plädoyer in zehn Punkten." In "*Ästhetisierung*"*: Der Streit um das Ästhetische in Politik, Religion und Erkenntnis*, edited by Ilka Brombach, Dirk Setton, and Cornelia Temesvári, 119–33. Zurich: Diaphanes.

Galison, Peter. 2001. "Peter Galison Interviewed by Oladélé Ajiboyé Bamgboyé, Okwui Enwezor, Kobe Matthys, and Barbara Vanderlinden."

In *Laboratorium*, edited by Hans-Ulrich Obrist and Barbara Vanderlinden, 95–107. Antwerp: DuMont / Antwerpen Open / Roomade. Published in conjunction with the exhibition of the same name organised by Antwerpen Open and Roomade in collaboration with the Provincial Museum of Photography, shown at various venues in Antwerp.

Giedion, Sigfried. 1929. "Lebendiges Museum." *Der Cicerone: Halbmonatsschrift für Künstler, Kunstfreunde und Sammler* 21 (4): 103–6.

Gießener Preis für wissenschaftliche Präsentation und Lecture Performance. 2011. "Performing Science 2011: Die Idee." Performing Science2, Zentrum für Medien und Interaktivität (ZMI), Justus-Liebig-University Giessen. Accessed 24 April 2013. www.performingscience.de/.

Hacking, Ian. 1999. *The Social Construction of What?* Cambridge, MA: Harvard University Press.

Kreuzer, Stefanie, ed. 2012a. *Experimente in den Künsten: Transmediale Erkundungen in Literatur, Theater, Film, Musik und bildender Kunst*. Bielefeld: Transcript.

———. 2012b. Introduction to Kreuzer 2012a, 7–15.

Lab.D. 2013. Homepage of Lab.D: Laboratory for Dimensional Research at the Academy of Media Arts Cologne. Accessed 24 April. http://labd.khm.de/.

Lyotard, Jean-François. 1986. "Philosophie und Malerei im Zeitalter ihres Experimentierens." In *Philosophie und Malerei im Zeitalter ihres Experimentierens*, translated by Marianne Karbe, 51–77. Berlin: Merve. Essay first published 1981 as "La Philosophie et la peinture à l'ère de leur expérimentation" (*Rivista di Estetica* 9).

Mainberger, Sabine. 2010. *Experiment Linie: Künste und ihre Wissenschaften um 1900*. Berlin: Kulturverlag Kadmos.

Molderings, Herbert. 2006. *Kunst als Experiment: Marcel Duchamps "3 Kunststopf-Normalmasse."* Munich: Deutscher Kunstverlag. Translated by John Brogden as Molderings 2010.

———. 2010. *Duchamp and the Aesthetics of Chance: Art as Experiment*. Translated by John Brogden. New York: Columbia University Press. First published as Molderings 2006.

Popper, Karl. (1959) 2002. *The Logic of Scientific Discovery*. Abingdon, UK: Routledge. First published 1935 as *Logik der Forschung* (Vienna: J. Springer). English edition first published 1959 (London: Hutchinson).

Rancière, Jacques. 2009. *The Emancipated Spectator*. Translated by Gregory Elliott. London: Verso. First published 2008 as *Le spectateur émancipé* (Paris: La Fabrique éditions).

Rheinberger, Hans-Jörg. 1992. *Experiment, Differenz, Schrift: Zur Geschichte epistemischer Dinge*. Marburg an der Lahn: Basilisken-Presse.

———. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

———. 2005a. *Iterationen*. Berlin: Merve Verlag.

———. 2005b. "Nichtverstehen und Forschen." In *Kultur Nicht Verstehen: Produktives Nichtverstehen und Verstehen als Gestaltung*, edited by Juerg Albrecht, Jörg Huber, Kornelia Imesch, Karl Jost, and Philipp Stoellger, 75–81. Zurich: Edition Voldemeer.

———. 2006. "Über die Kunst, das Unbekannte zu erforschen." Cogito Foundation. Accessed 24 April 2013. www.cogitofoundation.ch/pdf/2006/061025DieKunst_dasUnbekannte.pdf. Delivered as a lecture given at an award ceremony at the Cogito Foundation, Zurich, 25 October 2006.

———. 2007. "On the Art of Exploring the Unknown." In *Say It Isn't So: Art Trains Its Sights on the Natural Sciences*, edited by Peter Friese, Guido Boulboullé, and Susanne Witzgall, 82–93. Heidelberg: Kehrer Verlag. Published in conjunction with the exhibition of the same name, shown at the Weserburg, Museum für moderne Kunst, Bremen. Chapter first published as Rheinberger 2006.

———. 2010. *An Epistemology of the Concrete: Twentieth-Century Histories of Life*. Durham, NC: Duke University Press. First published 2006 as *Epistemologie des Konkreten* (Frankfurt am Main: Suhrkamp).

———. 2011. "Experimentelle Virtuosität." In *Kongress-Akten der Deutschen Gesellschaft für Ästhetik*, edited by Ludger Schwarte.

Deutsche Gesellschaft für Ästhetik. Accessed 12 June 2013. www.dgae.de/downloads/Rheinberger.pdf.

———. 2012. "Experimental Systems: Difference, Graphematicity, Conjuncture." In *Intellectual Birdhouse: Artistic Practice as Research*, edited by Florian Dombois, Ute Meta Bauer, Claudia Mareis, and Michael Schwab, 89–99. London: Koenig Books.

Rodtschenko, Alexander. 1993. *Alles ist Experiment: Der Künstler-Ingenieur*. Edited by Pierre Gallissaires. Hamburg: Nautilus.

Rotman, Brian. 1987. *Signifying Nothing: The Semiotics of Zero*. New York: St. Martin's Press.

Schaub, Mirjam. 2010. *Das Singuläre und das Exemplarische: Zu Logik und Praxis der Beispiele in Philosophie und Ästhetik*. Zurich: Diaphanes.

Schmidt, Siegfried J., ed. 1978. *Das Experiment in Literatur und Kunst*. Munich: Fink.

Schnädelbach, Herbert. 2002. *Erkenntnistheorie zur Einführung*. Hamburg: Junius.

Stafford, Barbara. 1994. *Artful Science: Enlightenment, Entertainment, and the Eclipse of Visual Education*. Cambridge, MA: MIT Press.

Steiner, Theo. 2006. *Duchamps Experiment: Zwischen Wissenschaft und Kunst*. Munich: Fink.

Stiegler, Bernard. 2011. "Allgemeine Organologie und positive Pharmakologie (*Theorie und ›praxis‹*)." In *Die technologische Bedingung: Beiträge zur Beschreibung der technischen Welt*, edited by Erich Hörl, 110–46. Berlin: Suhrkamp.

Thomas, Karin, ed. 2006. *Kunstlexikon des 20. Jahrhunderts: Künstler, Stile und Begriffe*. 2nd ed. Cologne: DuMont.

Welsch, Wolfgang. 1990. *Ästhetisches Denken*. Stuttgart: Reclam.

Toward a Practice of Novel Epistemic Artefacts

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INTRODUCTION

When I returned[1] to art and artistic design[2] in 1992 I found myself in the midst of radical changes arising largely out of developments in UK science and educational policy in which the art and design sector found that it had a place at the table where the national game of research was played. Thus a field of play opened up in front of artistic design UK in the presence of a dispute[3] about what kind of game it wanted to play there and with little appreciation of the rules of the games already active in it. Yet, based on the histories of established research-led disciplines, joining the game committed artistic design to a path likely to lead to a professional research class. I have described this entry into the professional game of research as an experiment; but what kind of experiment did I mean?[4] Donald Schön ([1983] 1991, 145) has articulated three kinds of experiment: "What if?," where action is taken to see what follows without accompanying predictions or expectations; move testing, where a deliberate act is made with an end in mind; and hypothesis testing, where there is an attempt to discriminate between competing hypotheses. I do not think it is an exaggeration to say that, at its outset, the UK Higher Education sector's entry into artistic research constituted a "What if?" experiment: the sector fell into research.

In the UK, the bravado of this gesture has been felt most forcibly by doctoral research students, closely followed by their advisors.[5] Whilst it can be argued

1 I studied fine art at Leicester Polytechnic and the Slade School of Art, University College, London, before completing a PhD in Computer Science. Subsequently, I taught and undertook research in computer science over a period of eighteen years ending in 1992, when I joined the Derby School of Art and Design as associate dean with responsibility for research.

2 In Scrivener and Zheng (2012), we draw a distinction between two traditions of design and design research: one technology- and engineering-led, and largely university-based; the other humanities- and creativity-led and largely based in what were called polytechnics and independent art and design colleges. To refer to the activities of the former tradition we used the terms design and design research and for those of the latter, the terms artistic design and artistic design research. Here, to signify that I am talking about design located within the former polytechnic / independent college sector, I retain the terms artistic design and artistic design research.

3 This is evident in the now extensive literature on practice-based or practice-led research.

4 See Scrivener (2006, 162–63). This text also gives an account of the changes in science and education policy referred to earlier.

5 This is so because artistic design in the UK has been able, up to the present at least and to a lesser or

that to enter into any doctoral degree programme is to step into a liminal space in which one is transformed from one who receives and uses existing knowledge to one who acquires and disseminates new knowledge, in most academic fields the rights of passage are known and widely shared. In other words, a tradition of research offers past futures to draw upon in anticipating future futures. Anticipation can be seen as a light that illuminates the way forward; in its absence there is darkness. Hence, if the artistic design sector can be said to have initiated a "What if?" experiment in the creation of a new practice, called artistic design research, in practice this is being worked through in a host of local, situated experimental settings, each populated by doctoral students and advisors. For the doctoral student, this involves a double experiment: an experiment aimed at instantiating a mode of artistic research; and an experiment using artistic research to acquire new knowledge and understanding. Similarly, the doctoral advisor is engaged in an experiment addressing the conditions of the institutional setting, where attention is being given to what can be retained of pre-doctoral artistic design practice, what might be added, and how to condition the local setting such that these determinations yield artistic design research, both as practice and product.[6] In this plethora of local manoeuvres, artistic design research is gradually moving beyond "What if?" to "move-testing," to hypothesis-testing experimentation, and, ultimately, to stable practices of artistic design research.

Indeed, my own writing on the topic of artistic research, which can be understood as originating in difficulties experienced in the supervision of artistic design research students, seeks to contribute to these manoeuvres in that it is directed toward the framing of a supervisory practice adequate to the demands of a wide variety of artistic research doctoral programmes (Scrivener 2000, 2002, 2006, 2009, 2011a, 2011b, 2011c; Scrivener and Zheng 2012). Here, it is not my intention to draw explicitly on this writing; rather, my plan is to re-examine some of the ideas developed in it through a Rheinbergian lens, in anticipation of new and expanded ways of seeing them. This rewriting of ideas might be said to be "after Rheinberger" in the sense that, whilst focussing on specific elements of Rheinberger's account of the scientific practice of experimentation, the rewriting, as a whole, is tacitly shaped by the broader repertoire of concepts that Rheinberger articulates.

WHEN PAST EXPERIENCE FAILED

During my career in computer science I acquired extensive experience in a wide variety of design research, particularly that which I have called problem solving design research (Scrivener 2000). Typically, this kind of research begins

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greater degree, to ignore questions about both the nature of artistic design research and the changes in practice demanded by any given version of it. If the game of competitive funding is played well at the input—i.e., AHRC—and output—i.e., Research Assessment Exercise—ends of peer review, then artistic designers are able to acquire funding to support their artistic design practice without the need for substantive change in artistic design practice.

6 Or at a minimum, research of some recognisable kind, e.g., art historical, sociological, archaeological, etc.

with the observation of problematic situations in the designed world that point to a problematic situation in designing; the problem is then critiqued in order to understand how we might expand design to encompass its solution; the critique then leads to a proposal for a revised or new method of designing. For example, it might have been observed that websites are often unusable. Investigation might reveal a lack of effective usability evaluation methods for website evaluation and redesign, thus encouraging research to develop, test, and validate a new or enhanced way of designing aimed at overcoming the limitations of current methods. Testing is achieved by applying the method to the design or redesign of an artefact, which is then evaluated to ensure that it ameliorates or eradicates the observed problem, thereby affirming the new way of designing. However, since a new or revised method has been produced, we don't just have a single solution: the method promises a space of possible solutions. The affirmed method stands as the outcome of the research, its contribution to knowledge; and the artefacts developed for testing purposes can be and usually are consigned to waste. Much design research, up to the emergence of the promise of artistic research, can be described as problem-solving, methods development.

What I discovered, post-1992, was that my past experience as researcher and researcher supervisor did not work with artistic design doctoral students,[7] because it represented, for them, an unbridgeable disjunction between their practices as artistic-design students and what was being asked of them as practitioners-of-design-research students.[8] Rather than compelling students to more or less discard past practice to comply with a practice that I had mastered, I chose to explore how artistic design practice might be understood as research, that is, as a practice capable of yielding new knowledge and understanding. This inquiry has brought me to claim that artistic design should be understood as research when works of artistic design engender surprise in their viewers (Scrivener 2011c).

COGNITIVE SURPRISE

In the introduction to his book *Surprise, Uncertainty, and Mental Structures* Jerome Kagan writes that "events that are transformations of an agent's psychological forms are significant incentives for brain activity and its psychological consequences... Events that are discrepant from schemata create a state one might call *surprise*" (Kagan 2002, 4). Surprise occurs when one's expectations do not fit the situation. A staged model of cognitive surprise has been proposed in which a cognised event is appraised using a mechanism that computes the degree of discrepancy between the cognised event and existing beliefs and then tests this value against an unexpectedness threshold (Meyer, Reisenzein, and Schützwohl 1995). Crossing the unexpectedness threshold is accompanied

7 I was also encountering the same difficulties, perhaps for obvious reasons, with fine art students that I was supervising at the same time.

8 See Scrivener (2000, 2002) for a discussion of apparent causes of this failure.

by the experience (emotion) of surprise, followed by the interruption of ongoing information processing and the reallocation of processing resources to the analysis and evaluation of the unexpected event and its resolution, that is, the updating and revision of the existing schemas or beliefs (Meyer, Reisenzein, and Schützwohl 1997; Reisenzein 2001). By interrupting and refocusing attention and cognitive resources, the surprise mechanism functions to enable an initial motivational impetus for immediate adaptation to the surprising event and cognitive change, enabling future occurrences of similar events to be handled. Thus surprise generates curiosity by informing the conscious self about the occurrence of a schema discrepancy. Since this information concerns one's belief system it involves a metacognitive process: cognition about cognition or knowing about knowing. Surprise, then, provides an impetus for meta-cognition and the exploration and explanation of the unexpected event (Reisenzein, Meyer, and Schützwohl 1996). Hence, cognitive surprise is one way that an artistic design artefact might be instrumental in changing an observer's beliefs. However, when we use the word "surprise" we are not always referring to cognitive surprise.

FELT DIFFICULTY, COGNITIVE SURPRISE, AND RESEARCH

In our everyday, active lives our ideas about the world in which we experience ourselves as being situated and acting sit comfortably with our past beliefs and our beliefs as to the future. Only rarely, as for example in cognitive surprise, do our beliefs about past, present, and future fall out of agreement with one other. John Dewey gives the term "felt difficulty" to such discrepancies and describes the reflective operation of realigning them as follows: "Upon examination, each instance [of the reflection operation] reveals, more or less clearly, five logically distinct steps: (i) a felt difficulty; (ii) its location and definition; (iii) suggestion of possible solution; (iv) development by reasoning of the bearings of the suggestion; (v) further observation and experiment leading to its acceptance or rejection; that is, the conclusion of belief or disbelief" (Dewey 1910, 72). The instances that he refers to are as follows: someone notices the time shown on a clock and is reminded of a meeting in forty minutes, which causes reflection on the best way of getting to the meeting on time; someone notices what looks like a flagpole projecting from a ferryboat, which causes reflection on its function in this location; whilst washing glasses the dryer notices that bubbles appear on the outside of the mouths of the glasses and then go inside, which leads to a cycle of thinking and experimenting leading to a tested theory of the phenomenon. Dewey describes these examples as forming a series from rudimentary to complicated cases of reflection, the first entirely solvable within the limits of everyday experience, the third requiring specialised experience for its solution, and the second as a natural transition between them in that the problem "instead of being directly involved in the person's business, arises indirectly out of his activity, and accordingly appeals to a somewhat theoretical and impartial interest" (71). Dewey goes on to explain that "observation exists at the beginning and again at the end of the process: at the beginning, to

determine more definitely and precisely the nature of the difficulty to be dealt with; at the end, to test the value of some hypothetically entertained conclusion" (77). Thinking (that is, inference and reasoning) connects these observations at beginning and end and yields a theory of the problem and a hypothetically entertained conclusion for testing. Dewey conceived of the reflective operation broadly, defining it as an "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of grounds that support it, and the further conclusions to which it tends" (6). With reference to its operation in the full scope of human activity he observes that "if we are willing to generalize our conceptions of our mental operations to include the trivial and ordinary as well as the technical and recondite, there is no good reason for refusing to give such a title [research or inquiry] to the act of looking" (10). If, for the moment, we are willing to do as Dewey invites us to do and see the entire reflective operation as research, then research is an activity where discrepancy between beliefs—as to the past, present, and future—about what enters via the senses must involve beliefs about the present. Hence, "felt difficulty" may be understood as originating in a relation between beliefs as to the present and the past, or the present and the future.

Dewey explains the difficulty felt by the observer reported in his first case as residing "in the conflict between conditions at hand and a desired and intended result" (72), that is, from uncertainty as to whether the anticipated future situation can be realised from the present situation; the second "is the incompatibility of a suggested and (temporarily) accepted belief that the pole is a flagpole, with certain other facts" (73); and "in the third case, an observer trained to the idea of natural laws or uniformities finds something odd or exceptional in the behaviour of the bubbles" (73). In each case, a relation of accord between thoughts concerning the present situation and those associated with past or future situations is not immediately forthcoming; and this lack of immediacy, this discrepancy, may be said to give rise to "felt difficulty." Research, à la Dewey, starts in the present situation with a feeling of difficulty and ends with a present situation in which difficulty is no longer felt. In the first and third cases that Dewey describes it can be claimed that the observers gain new knowledge of relevance to future practice: the first learns that there is a means of transport from 16th to 124th street that takes forty minutes, and the second is able to explain why soap bubbles appear first outside and then inside a tumbler warmed by sudsy water.

Nevertheless, none of the cases that Dewey cites can be understood as cognitive surprise because, although they satisfy the features of cognitive surprise to varying degrees and they appear to involve an emotion of felt difficulty, they do not interrupt the ongoing processing of situational information. Dewey's appreciation of "felt difficulty" is more general than cognitive surprise as it includes experiences that we might describe as surprising and yet that do not interrupt ongoing activity in a life situation. More precisely, notwithstanding Dewey's observation that his first and third examples are ones where the problem directly relates to their business (of doing business and science), the "business" at hand in each case is not interrupted; there is nothing in his account

to suggest that the activity of being "down on 16th Street," or of being on a ferryboat, or of "washing up tumblers" was interrupted (68–70).

The Reflective Operation, Problem-Solving Research, and Reflective Practice

With Dewey's reflective operation in mind it is, perhaps, easier to see why the design problem-solving activity that I described above might be understood as research, since it comprises the five logically distinct steps that he assigns to it: (i) it begins with a felt difficulty in the designed world; (ii) the nature of the difficulty is clarified; (iii) suggestions as to causes of the problem are explored and probable explanations developed (which may or may not be formally tested); (iv) the preferred theory is then used to propose a theory of how the problematic situation might be redesigned such that the problem does not continue to occur; (v) the problematic situation is redesigned and tested to ascertain whether the observed problem has been eradicated or ameliorated. There are a number of differences in the operations as described here that are worth dwelling on further. First, if there is a "felt difficulty" that enters into problem-solving design research, it is usually one experienced by another and reported to the researcher. Second, the observation and experimentation, often requiring effortful, deliberate, and extensive arrangement of conditions, usually occurs throughout steps (ii) to (iv). Third, design research is the primary practice of the design researcher, not something that is occasionally lapsed into during the exercise of another practice, for example, the practice of getting from one place to another or something more specialised, such as professional design. Problem-solving design research is a specialised, professional, and institutional form of the reflective operation, developed so as to generate knowledge that, when applied by the professional designer to intervene in the artefactual world, is likely to enrich human experience.

A further feature of problem-solving design research that is particularly relevant to the design practitioner is that the practice of design is largely held in suspension until the fourth step of the operation. As such, the move from the practice of design into the practice of problem-solving design research can be the cause of considerable anxiety and resistance for many artistic doctoral design students. Many of those looking to ease the transition of the doctoral artistic design student from one practice to the other have found encouragement in Donald Schön's theory of reflective practice.

In *The Reflective Practitioner* ([1983] 1991), Schön articulated the gap between how we think about and theorise practitioner competence and the realities of practice. According to Schön, in practice, professionals function as reflective practitioners rather than rational problem solvers. Since its publication in 1983, many professions have taken and built upon the ideas articulated in the book to invigorate professional education, training, and practice. Schön's primary insights were that, in practice, ends are not known and cannot be known in advance because every practice situation is unique and practitioners draw heavily on tacit knowledge and appreciations acquired over years of practice

to deal with the uniqueness of each new task. In short, Schön took the practice situation as given and focussed on how, first, the uniqueness of a particular situation comes to be understood by the practitioner through the surfacing and theorising of the failure of practitioner knowledge and, second, how that knowledge is expanded to satisfy the demands of the situation at hand.[9]

Nevertheless, whether we are talking about rational problem-solving or reflective practice, each procedure works from a given material or life situation. What the two approaches offer are different ways of dealing with situational problems and different ways of marshalling prior skills, knowledge, and understanding so as to resolve them; but under a theory of reflective practice only some situational difficulties need to be attended to. Schön argues that two variables (consequences in relation to intention and desirability of all perceived consequences, intended or unintended) combine to constitute four conditions for reflection: undesirable surprise, desirable or neutral surprise, no surprise that is desirable or neutral, and no surprise that is undesirable. Only undesirable conditions demand reflection, whereas the desirable conditions can be passed over without reflection, regardless of whether or not they are accompanied by surprise. Schön justifies the practitioner's response to desirable surprise as follows: "In the second case [desirable surprise], the inquirer's expectation is disappointed but the consequences taken as a whole are considered desirable. The associated theory is refuted but the move is affirmed... According to the logic of affirmation, the move has succeeded... she [the inquirer] need not reflect on it" (Schön [1983] 1991, 155–57). Schön is indebted to Dewey in the use of some of his terms, but chooses the term surprise, rather than "felt difficulty," to describe the feeling associated with a discrepancy among beliefs about past, present, and future (ibid., 135n38). In fact, we can see that his term "surprise" approaches cognitive surprise when qualified by the adjective "undesirable": undesirable surprise demands that the practitioner disengage from the task in hand to enter the reflective operation, whilst surprise, qualified by the adjective "desirable," is a weak "felt difficulty," as the surprised may not be sufficiently stimulated, or may choose to ignore sufficient stimulation, to enter the reflective operation, thus prioritising progression of the task in hand.

Although Schön distinguishes different qualities associated with the feeling of surprise, that is, desirability and undesirability, only undesirable surprise demands attention to and reflection on the ideas from which expectations are derived; and even then, the reflective cycle can be exited as soon as the practitioner can see a way forward. Hence, we see that, in the theory of reflective practice, the logic of affirmation has priority over that of confirmation; "in the practice context, priority is placed on the interest in change and therefore on the logic of affirmation" (Schön [1983] 1991, 155).

The appeal of Schön's epistemology of practice is that it locates the reflective operation within the practice of design as something that arises directly out

9 In my opinion, those familiar with Schön's epistemology of practice and Rheinberger's account of scientific practice will not fail to be struck by the resonances between them.

of that practice. Additionally, it appears to capture many of the realities of the designer's experience, whether artistic or not; indeed, it also resonates with practical experience of the problem-solving design researcher. However, what is less appealing about reflective practice, that is, the logic of affirmation, is that it resists expansion of steps (ii)–(v) of the reflective operation that Dewey (1910, 74) believes "makes the difference between reflection proper, or safeguarded *critical* inference and uncontrolled thinking."[10] The reflective practitioner dwells in the reflective operation only for as long as it takes to make a move that is not one that registers undesirable surprise.

If one wanted to take reflective practice as a process from which some things are to be removed and others added in order to arrive at something we could call artistic design research, we might say that the revised process will need to be one in which one or more of the steps in the reflective operation are critically expanded, as it is through this expansion that artistic design would transform itself into artistic design research. However, to prevent this transformation of practice through the critical expansion in the reflective operation from degenerating into problem-solving design research, the largely observational, inferential, and rational operations of the reflective operation will need to be significantly enriched through the synthetic material and representational operations typical of artistic design. [Fig. 1]

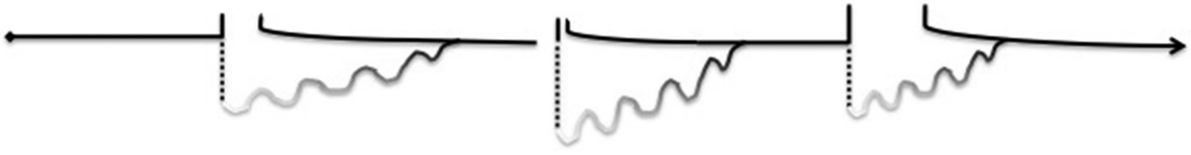

Fig. 1

The process alluded to above is sketched in figure 1, where there is movement into and out of the reflective operation (shown here by a wavy line). The question that now needs to be asked is: What is the nature of the activity that connects the cycles of reflective operation into a biography? We might want to nominate the unreflective element of reflective practice as the gap filler, but to do so is to limit the possibilities, for the following reasons.

First, as we have seen, in both reflective practice and the reflective operation, "felt difficulties" or surprises are not sought, they just happen to the active agent; indeed, in both cases there is nothing in the theories designed to create them, and there is a sense (registered in the words "difficulty" and "undesirable") that, when they happen, they are unwelcome. Second, the unreflective element of reflective practice discounts desirable surprise as a trigger for the reflective operation even though the fact that the refutation of theory is accompanied by the feeling of desirability is a sign that the present situation might be surplus to theory; the transformed situation is more than expected. Schön's logic of affirmation focuses on what ought to be, not what might be.

10 In fact, in the quoted passage Dewey is referring to the collapsing of steps (i) and (ii). However, collapse between any two steps would be subject to the same critique.

Figure 1. Reflective artistic design research practice.

Thirdly, reflective practice is constrained, by the given problematic artefactual situation that the practitioner must remedy, to questions such as "How can the world be made to be better than it currently is?" Reflective practice does not seem to support questions of the form "How can a new world be made?"

Having reached the conclusion that we have to look beyond everyday experience and reflective practice for a more ambitious and proactive activity that binds cycles of reflective operation together to yield new insights into the designed future, I now want to consider how Rheinberger's theory of scientific experimentation offers a light to illuminate a way forward.

UNPRECEDENTED EVENTS, EPISTEMIC THINGS, AND EXPERIMENTAL SYSTEMS

In essence, Rheinberger turns scientific experimentation on its head, from an activity designed to confirm theory to a system for generating unprecedented events and epistemic things, things embodying concepts, in which testing functions more as a means of affirmation than confirmation.

I want to start my consideration of this "turn" with Rheinberger's observation that in "the classical formulation of Karl Popper [(1959) 2002, 89], 'the theoretician puts certain definite questions to the experimenter, and the latter, by his experiments, tries to elicit a decisive answer to these questions, and to no others'" (Rheinberger 1997, 27).

In opposition to this view, Rheinberger argues that scientific experimentation largely takes place within an experimental system that, to be productive, must produce unprecedented events as the material foundation from which epistemic things can be brought into existence and worked with, observing that: "As a rule, the new is the result of spatiotemporal singularities. There is reason to assume that this is especially the case in matters of knowledge. Indeed, experimental systems are arrangements that allow us to create cognitive, spatiotemporal singularities. They allow us to produce, in a regular manner, unprecedented events" (23). After allowing the term "unprecedented event" to appear in a number of guises, such as "experimental systems... as 'generators[s] of surprises'" (3), "unprecedented and unanticipated events" (3), "new phenomena" (21), "cognitive, spatial, temporal singularities" (23), "unexpected ways" (23),[11] and "surprising result" (75), Rheinberger, rather than defining the term, settles upon it as being preferable to "the often used notion of 'discovery'" (133–34). Given Rheinberger's use of words above, it is reasonable to suggest that any unprecedented event can be understood as lying somewhere between cognitive surprise and "felt difficulty."

Returning to consider Rheinberger's reference to discovery and relating this to his critique of Popper, we should note that Popper believed that scientific discovery exists in the realm of theory. For him, the main scientific task amounted to showing the "discovered to be a discovery, or known to be knowledge" (Popper [1959] 2002, 9–10); in other words, the task, including the

11 The term is introduced by means of a citation.

final experimental stage of testing, comprised a logically rigorous, expanded, disinterested, and entirely deductive version of steps (iv) and (v) of Dewey's reflective cycle. Of the steps leading up to this task, that is, steps (i) to (iii) in Dewey's reflective operation, Popper observed that:

> The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it. The question how it happens that a new idea occurs to a man—whether it is a musical theme, a dramatic conflict, or a scientific theory—may be of great interest to empirical psychology; but it is irrelevant to the logical analysis of scientific knowledge... However, my view of the matter, for what it is worth, is that there is no such thing as a logical method of having new ideas, or a logical reconstruction of this process. My view may be expressed by saying that every discovery contains "an irrational element," or "a creative intuition," in Bergson's sense. (ibid., 7–8)

Hence, Rheinberger's view of discovery as unprecedented event, and of an experimental system as one that regularly yields them, radicalises the classical notion of experimentation, as it pushes its basis not simply back to step (iii), but back beyond step (i), that is, the emotion of surprise, felt difficulty, or unprecedented event. An experimental system is designed to generate unprecedented events, rather than wait for them to happen; furthermore, its "future development depends upon groping and grasping for differences [unprecedented events, in the first instance]." In short, an experimental system is a system of "differential reproduction" in which reproduction depends upon the regular production of unprecedented events (Rheinberger 1997, 75). As such, Rheinberger's theory is not solely a radical view of scientific experimentation; it also offers a model for experimentation in artistic design research that embodies the active generation of an unprecedented event that we are looking to see between cycles of reflection (as shown in figure 1).

The Eye-Jump Doctoral Research Project (Zheng 2007)

With the above supposition that Rheinberger's experimental system offers a potential model for experimentation in artistic design research, I would like to reflect on the work of one of my doctoral students both with respect to how it differed from problem-solving design research and the extent to which, in retrospect, it can be viewed as an experimental system. The Eye-jump research project concerned the design of interactive exhibits that support children's learning. The first achievement of this project was the production of a working design prototype, called Eye-jump.[12] At first sight, Eye-jump looks like a normal skipping rope. However, when rotated, light-emitting diodes embedded in the translucent "rope" are illuminated under the control of display technology housed in the skipping rope handles. [Fig. 2a & 2b]

12 A more detailed account of the material presented in this section can be found in Scrivener and Zheng (2011).

Fig.2a

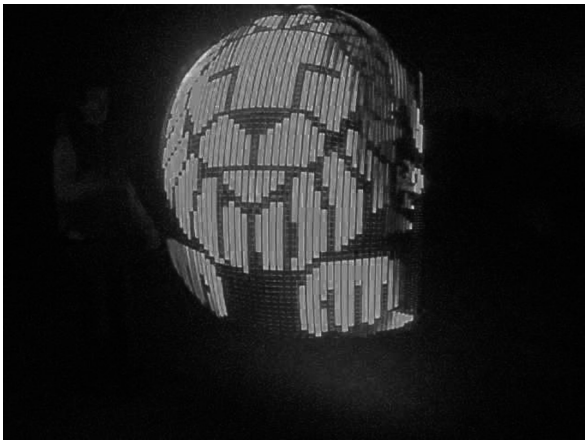

Fig.2b

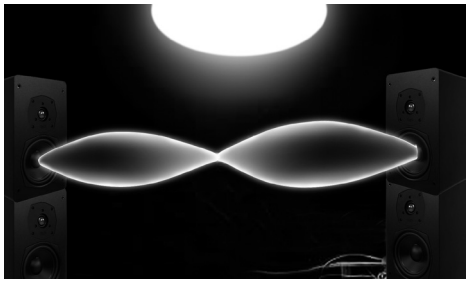

Fig.3a

Fig.3b

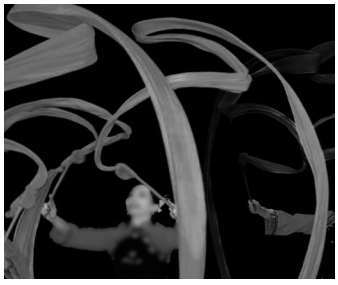

Fig.3c

This technology can be programmed to display images in a manner rather like a cathode ray tube, where pixels are individually illuminated in sweeping raster lines from the top to the bottom of the screen. The Eye-jump screen is that part visible to any viewer of the sphere created as the rope sweeps over the skipper's head and under his or her feet in constant rotation. When the rope is rotated at the threshold frequency, diodes concealed in the rope illuminate and change to display the next line of the image until the whole image has been presented; this cycle is repeated for as long as the skipper maintains the conditions for display. For children (and adults, in fact), the behaviour of this apparently familiar plaything—a skipping rope—is surprising; and this surprise represents a rupture in understanding that encourages curiosity and experimentation in order to adjust understanding to accommodate the surprising event. For the researcher, the invention of Eye-jump was punctuated by a series of—looked for—"felt difficulties," three of which are shown in figure 3. [Fig. 3a, 3b & 3c]

To what extent, then, is the Eye-jump process interpretable as an experimental system? For Dewey and Schön, an unprecedented event is a problematical relation between an observer and a given material situation; whereas the scientific researcher, in Rheinberger's view, establishes a material situation, an experimental system, designed to enhance the probability and regularity of unprecedented events. They are not just left to chance; the experimental system, like a net, is thrown out and played in anticipation of catching them. Likewise, Zheng stepped out of the given situation, as explained below:

Figure 2. *Left*, the Eye-jump prototype when static before skipping commences; *right*, when rotated at display velocity, skipping reveals a lion image.

Figure 3. Three related screen concepts: *left*, the string concept; *centre*, the rod concept; *right*, the ribbon concept.

> In order to re-direct the study, a question came to mind: What are the options if I discard the current design research approach [commencing from the analysis of existing interactive museum exhibits]? The question led to a set of design objectives based on an appreciation of surprising design: I should produce a design that exemplifies an original idea and provides a unique experience; is fun and playful; is intuitive for children to use; and motivates children's learning. These were the only foundational objectives that I set myself. The intention was to leave enough space and freedom to explore design opportunities. (Scrivener and Zheng 2011, unpaginated)

To work with these ideas, a material situation, a system of manipulation, was created in the hope that it might give unknown answers to questions that could not be clearly asked (ibid.). Figure 3 shows three of the concepts that entered into Zheng's experimental system, building upon an earlier experiment in which an image had been projected onto a rotary fan; all of these "things" registered as "felt difficulties" in that they presented problems of one kind or another. Zheng has described how this process was closed by another kind of desirable surprise, a "eureka" (emotion) moment, in which the idea of using a skipping rope as a display arose spontaneously upon observing a child's skipping rope on a sofa in a friend's home.

In examining the emergence of this surprising artefact, which itself stands as an "unprecedented event," to borrow Rheinberger's term, it is evident that the Eye-jump project process was driven by a set of only loosely related ideas selected under the operation of a personal belief system and for their ability to activate the researcher's motivation, commitment, and emotional engagement. Also evident in the exchange between researcher and supervisor was a resistance to being narrowed down to a particular problem for analysis, interpretation, and resolution. We also saw that, perhaps due to personal beliefs, interests, and motivations, the researcher's preference was to progress this rather loose nexus of interests and concerns via a process of design ideation, rather than through conceptual and empirical analysis. The Eye-jump concept emerged at a relatively early stage in the process and its novelty was recognised by all concerned, although there we no illusion that "it [was] the inevitable product of a logical inquiry or of a teleology of the experimental process" (Rheinberger 1997, 74).

The process of understanding the significance of the artefact was driven by a demand for an explanation of why and how this novel artefact fulfilled the research ambitions of the project. Finding such an explanation required intense engagement with prior understanding in a number of different fields. However, in contrast to the function of the literature review in most conventional research, including problem-solving design research, this was not done to identify a question or problem worthy of subsequent research, but to account for a novel design solution. Making sense of the surprising artefact enabled a theory to be constructed that drew upon prior understanding of cognitive surprise, cognitive development, learning, and creativity. The behavioural and cognitive affects and effects of engagement with the device were then experimentally tested, and the theory was used to produce a framework of principles and criteria that other designers might employ to construct surprising artefacts.

Like problem-solving design research, the work was directed toward a desirable future. However, problem-solving design research begins with an undesirable situation in the designed world that prompts reflection, for example, "Why is this artefactual situation not as it ought to be?" That is to say, the process begins with the recognition that there is something known: a better world, which has not been realised. The Eye-jump story, in contrast, began with making and thinking that was not attached to specific instances of undesirable life conditions; it was not concerned with what ought to be but with what might be. In a problem-solving research process a theory of the problem is transformed into a theory of its solution, which is then affirmed through the testing of a new design; material interventions are solely for the purposes of testing the solution theory. In contrast, the Eye-jump project progressed from untargeted material interventions, through unprecedented artefactual situation, to reflection on its potential significance.

As noted earlier, when the researcher confronts an artefactual situation that is judged to be undesirable, the researcher is aware of something in the situation that fails to live up to expectation. This gap between the world as it is and the world as we believe it should be is registered negatively; it stands as a mark of the fact that the artefactual world is less than our ideas promise it to be. Whatever the researcher does to close this gap amounts to the satisfaction of ideas already possessed; it is a matter of making our ideas work as we want them to. Under these circumstances, our design acts are measured against anticipations arising from prior ideas. As we have seen, in the Eye-jump process the search for problems, whether through empirical observation or the critical analysis of prior understanding, was eschewed. Instead the researcher focused on design ideation, guided by a set of loosely articulated associations, which resulted in the creation of an unprecedented artefact. If we consider a successful outcome of the problem-solving design research process, then we would expect it to register satisfaction, even pleasure, in the researcher, but not surprise. Rather, it will be experienced as familiar, even obvious; something that we knew was possible, even if we weren't aware of this fact until the moment of its cognition. In contradistinction, the Eye-jump concept registered surprise, accompanied by curiosity, because we find ourselves in the midst of an experience that is outside immediate apprehension, which is then followed by reflection on its nature for comprehension.[13]

To conclude this section, Rheinberger, Dewey, and Schön might be said to refer to the same cognitive phenomenon when using terms such as unprecedented event, "felt difficulty," and surprise; but a distinction can now be drawn between how such a phenomenon is responded to and the cycle in which it occurs. In all cases, unprecedented events happen. However, in Schön's theory of reflective practice, surprises are not sought and are not welcomed, which limits the process to one of problem solving. Although Dewey's reflective operation is responsive to "felt difficulty" that lacks any feeling of undesirability,

13 As noted earlier, this reflection can be understood as a critically expanded, rigorous, thoughtful, and temporally extended instance of Dewey's reflective operation.

"felt difficulty" is by no means sought. From these perspectives, reflective thought annihilates the unprecedented event to attain a new direction that restores equilibrium and allows the active agent to move forward on an even keel. In contrast, in the practice Rheinberger describes, and in the work of Zheng reported above, unprecedented events are viewed as positive; they are, in the first instance, practices for generating surprises, not for eradicating them when, in the midst of deliberate transformations of the material world, they present themselves; they are practices designed for the recurrent production of unprecedented events.

Nevertheless, a difference can be postulated between how unprecedented events come about in scientific experimentation, as articulated by Rheinberger, and how they came about in the Eye-jump process. "In what," asks Heidegger, "does the essence of research consist? In the fact that knowing establishes itself as a procedure within some realm of what is, in nature or in history" (Heidegger 1977, 118, quoted in Rheinberger 1997, 25). In discussing the unprecedented event, Rheinberger (1997, 23) quotes Michael Polanyi:

> this capacity of a thing to reveal itself in unexpected ways in the future, I attribute to the fact that the thing observed is an aspect of reality, possessing a significance that is not exhausted by our conception of a single aspect of it. To trust that a thing we know is real is, in this sense, to feel that it has the independence and power for manifesting itself in yet unthought of ways in the future.

Unprecedented events sometimes register "a feeling akin to respect: it [the feeling of reality] belongs primarily to whatever can do things to us without our voluntary co-operation" (Russell 1921, 186). This "it" that becomes present, in association with a feeling that it has an independence and power to manifest itself and, in so doing, to resist arbitrary or imprecise conceptions, appears as material lacking scientific concepts, which have to be derived from/imposed on it; or in Rheinberger's terms, concatenated in the process of bringing epistemic things into existence. They stand as the not-yet-epistemic things, things embodying concepts, to which concepts are forced to defer. In contrast, the Eye-jump research procedure was not concerned with what is in "nature," but with what the artificial might become. Where there are surprises in this context, even those coproduced with a feeling of reality, the procedure is opened up in the history of the artificial; and, therefore, the authenticity or validity of its epistemic things cannot be endlessly deferred to a feeling of reality. In this context, we perhaps can do nothing other than to put our trust in unprecedented events and in their indispensable role in the emergence of new epistemic artefacts.

Although the invention of the Eye-jump concept was not sufficiently well documented to enable the process to be read comprehensively and persuasively through the lens of Rheinberger's theory of the experimental system, there is sufficient evidence to suggest that Zheng's work stands as an example of a mode of artistic design research and of a thread of artistic design research practice running throughout the history of design, concerned with what might properly be called systems of differential artistic design reproduction, that is, experimental systems.

CONCLUSION

In the quest for a conceptual framework adequate to support a wide variety of artistic research doctoral student programmes, I have considered the merits of problem-solving design research, Schön's reflective practice, and Rheinberger's notion of the experimental system, as exemplified in the Eye-jump project. Problem-solving design research has been rejected because it appears incompatible with artistic design, which I take to embody that which will transfer, perhaps transformed, as the quality signified by the adjective "artistic" qualifying the mode of research. Reflective practice has merits as a theory of artistic design practice, but has the major limitation that unprecedented events, possible signs of the unknown, are not sought and are passed over as soon as their articulation offers a means of returning to the artistic design task in hand. The Eye-jump project, which was offered as an alternative route to new artistic design knowledge, can be interpreted in terms of concepts found in Rheinberger's theory, particularly those that concern experimental systems as arrangements that allow us to create unprecedented events in a regular manner. Unfortunately, space does not allow me to develop the conjecture that the Eye-jump prototype is an epistemic artefact, that is, an artefact embodying concepts.

Rheinberger's text is rich in concepts that can serve to develop the conjecture initiated here: that artistic design research can be conceptualised as an experimental system along the lines of those purportedly evidenced in science. However, before closing this chapter I would like to touch briefly on three notions that seem to me to have significant implications, and not simply for science. The first is the idea that science is a form of life—not simply, I think, in the sense that science reproduces itself, but in that every birth is the promise of a research scientist that is fulfilled if and when his or her naïve scientific acts are specialised through education and beyond into scientific research. This has implications for artistic design education, at all levels, if it is to be modified to support the development of artistic design research. The second is that the scientific life form embodies its history, traditions, and practices, as distinct from its explicit concepts, and that these are largely understood in the tacit dimension. This has implications for the development of artistic design research as a life form. Finally, although it is easy to see Rheinberger's work as primarily a contribution to the logic of discovery rather than the logic of confirmation, it seems to me that the history he recounts questions the very idea that there is anything like a classical logic of confirmation active in scientific practice, as least that which he describes. If this is the case, then we have to rethink what scientific communication amounts to, since concepts do not circulate together with their confirmation, as commonly held. This has implications for how we think about any addition to an epistemic artistic design artefact in which the concepts embodied in it are communicated in a disembodied manner.

REFERENCES

Dewey, John. 1910. *How We Think*. Boston: D. C. Heath.

Heidegger, Martin. 1977. *The Question concerning Technology and Other Essays*. Translated by William Lovitt. New York: Harper & Row.

Kagan, Jerome. 2002. *Surprise, Uncertainty, and Mental Structures*. Cambridge, MA: Harvard University Press.

Meyer, Wolf-Uwe, Rainer Reisenzein, and Achim Schützwohl. 1995. "A Model of Processes Elicited by Surprising Events." Unpublished manuscript, University of Bielefeld.

———. 1997. "Toward a Process Analysis of Emotions: The Case of Surprise." *Motion and Emotion* 21 (3): 251–74.

Popper, Karl. (1959) 2002. *The Logic of Scientific Discovery*. Abingdon, UK: Routledge. First published 1935 as *Logik der Forschung* (Vienna: J. Springer). English edition first published 1959 (London: Hutchinson).

Reisenzein, Rainer. 2001. "Appraisal Processes Conceptualized from a Schema-Theoretic Perspective: Contributions to a Process Analysis of Emotions." In *Appraisal Processes in Emotion: Theory, Methods, Research*, edited by Klaus R. Scherer, Angela Schorr, and Tom Johnstone, 187–201. New York: Oxford University Press.

Reisenzein, Rainer, Wolf-Uwe Meyer, and Achim Schützwohl. 1996. "Reactions to Surprising Events: A Paradigm for Emotion Research." In *Proceedings of the 9th Conference of the International Society for Research on Emotions*, edited by Nico H. Frijda, 292–96. Toronto: International Society for Research on Emotion.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

Russell, Bertrand. 1921. *The Analysis of Mind*. London: George Allen & Unwin.

Schön, Donald A. (1983) 1991. *The Reflective Practitioner: How Professionals Think in Action*. Aldershot, UK: Ashgate.

Scrivener, Stephen A. R. 2000. "Reflection in and on Action and Practice in Creative-Production Doctoral Projects in Art and Design." *Working Papers in Art and Design* 1. Accessed 16 January 2013. http://www.herts.ac.uk/artdes/research/papers/wpades/vol1/scrivener2.html.

———. 2002. "Characterising Creative-Production Doctoral Projects in Art and Design." *International Journal of Design Sciences and Technology* 10 (2): 25–44.

———. 2006. "Visual Art Practice Reconsidered: Transformational Practice and the Academy." In *The Art of Research: Research Practices in Art and Design*, edited by Maarit Mäkelä and Sara Routarinne, 156–77. Helsinki: University of Art and Design Helsinki.

———. 2009. "The Roles of Art and Design Process and Object in Research." In *Reflections and Connections: On the Relationship between Creative Production and Academic Research*, edited by Nithikul Nimkulrat and Tim O'Riley, 69–80. Helsinki: University of Art and Design Helsinki. PDF e-book.

———. 2011a. "Reflections on Interactive Art and Practitioner Research 1—Establishing a Frame." In *Interacting: Art, Research and the Creative Practitioner*, edited by Linda Candy and Ernest Edmonds, 60–72. Faringdon, UK: Libri Publishing.

———. 2011b. "Reflections on Interactive Art and Practitioner Research 2—Interpretation." In *Interacting: Art, Research and the Creative Practitioner*, edited by Linda Candy and Ernest Edmonds, 305–23. Faringdon, UK: Libri Publishing.

———. 2011c. "Transformational Practice: On the Place of Material Novelty in Artistic Change." In *The Routledge Companion to Research in the Arts*, edited by Michael Biggs and Henrik Karlsson, 259–76. Abingdon, UK: Routledge.

Scrivener, Stephen A. R. and Su Zheng. 2012. "Projective Artistic Design Making and Thinking: The Artification of Design Research." *Contemporary Aesthetics* special vol. 4. Accessed 16 January 2013. http://www.contempaesthetics.org/newvolume/pages/article.php?articleID=638Zheng2008.

Zheng, Su. 2007. "Promoting Children's Creativity: A Design Method for Interactive Museum Exhibits." PhD thesis, Coventry University.

Epistemic Complexity and Experimental Systems in Music Performance

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INTRODUCTION

In a process that was particularly enhanced in the twentieth century, the performance of musical "works" became a complex articulation of different types of data, information, and knowledge, retraceable in diverse material sources (including sketches, instruments, editions, recordings), in reflective discourses (*in*, *on*, and *about* music), and in multifarious performance "styles." The continuous accumulation and sedimentation of such kinds of knowledge represents an exponential growth of complexity that involves technical, artistic, aesthetic, and epistemic components. Such "complexity" might be labelled—borrowing a concept from the sciences (Dasgupta 1997; Kováč [2000] 2013; Kováč 2007)—"epistemic complexity."

Considering musical works as highly elaborated semiotic artefacts, I will situate different elements (such as sketches, manuscripts, editions, recordings, and articles) involved in music performance in terms of "epistemic complexity." By deconstructing works in this way, the tokens of their respective and variable complexity emerge as "boundary objects" (Star and Griesemer 1989), objects that change their ontological and epistemological nature depending on the context in which they are used.[1]

The dismantling of musical works into their graspable constitutive elements reveals them as complex accumulations of singularities, as multi-layered amalgamations of "things" (Kubler [1962] 2008; Brown 2001), disclosing open-ended possibilities for infinite new assemblages—raising questions of traceability, control, and critical assessment of the results. Hans-Jörg Rheinberger's notion

1 On the concept of "boundary object" in the context of artistic research, see Henk Borgdorff's interview with Michael Schwab (Borgdorff 2012, 174–83, particularly 177). Borgdorff attributes the concept of "boundary object" to Thomas F. Gieryn. However, Gieryn's concept is that of "boundary work," which has a different meaning, referring to instances in which frontiers, boundaries, limits, and demarcations between fields of knowledge are created, established, advocated, or reinforced (see Gieryn 1983). Borgdorff's use of the notion appears to be situated somewhere between "boundary work" and "boundary object" in the way I use the term here, which follows Star and Griesemer (1989).

of "experimental systems" seems to be a promising conceptual and methodological framework for the concrete practice of such new aesthetic-epistemic assemblages. In the central part of this chapter I will describe Rheinberger's thinking, preparing the reader for the application of this theory to music performance.

Beyond the mere (re)creation or (re)production of a work through performance, at stake in this chapter are processes that constitute musical "things" as objects for thought through performative devices. From this perspective the notion of epistemic complexity is just one element among many that contribute to a new mode of exposing musical objects. Methodologically this new mode is organised by different but interrelated approaches: identifying and scrutinising musical "things" that define a given musical work work (in the sense of an "archaeology"); studying their "epistemic complexity"; extracting them out of their traditional *Umwelt* and inserting them within the confines of experimental systems; and, finally, "exposing" them anew, in previously unheard reconfigurations of materials.

EPISTEMIC COMPLEXITY

In his essay "Experimental Complexity in Biology: Some Epistemological and Historical Remarks," Rheinberger (1997a, S245) states that "reduction of complexity is a prerequisite for experimental research." In other words, the overall context of research is characterised by complex configurations and arrangements of complex "things" that must be filtered and precisely selected to become part of the experimental setup. A vast number of components, interactions, behaviours, and embedded knowledges precede the experimental research itself. In order to do research and to arrive at some kind of result, the ontic complexity of the research object has to be reduced while retaining its fundamental and specific "epistemic complexity." Despite the title of his article, Rheinberger does not really address the topic of "complexity," since his central concern is with the experimental situation. Even when he writes that "experimental systems are machines for reducing complexity" (ibid., S247), he does not enter into a discussion of exactly what characterises this "complexity," a characterisation that would inform the "epistemic horizon" that enables the research in the first place. Further elaboration of the notion of "complexity" thus seems pertinent.

Biologist Ladislav Kováč and the philosopher Subrata Dasgupta—working separately and in different disciplines—have produced stimulating reflections on the topic of "epistemic complexity." According to Kováč (2007, 65), "biological evolution is a progressing process of knowledge acquisition (cognition) and, correspondingly, of growth of complexity. The acquired knowledge represents epistemic complexity." Dasgupta (addressing "technology and complexity") uses the same term in relation to artificial (i.e., human-made) things, defining complexity as "the richness of the knowledge that is embedded in an artefact" (Dasgupta 1997, 116).

Inspired by Hans Kuhn's understanding of life as an unceasing process of accumulation of knowledge that starts with self-copying nucleic acids (Kuhn 1972, 1988), Ladislav Kováč (1986) developed a "bottom-up" approach to

epistemological problems—an approach that may be associated with "cognitive biology"[2] and that conceives life as "epistemic unfolding of the universe" (Kováč [2000] 2013, 1). Biological evolution, based on a logic of self-replicating entities, is a continual growth of knowledge that involves the "creation of *subjects* with ever greater embodied knowledge" (ibid., 18, emphasis added). This principle presupposes that "there are levels of complexity in the living world and that, in the course of biological evolution, there has been a continuous growth of complexity" (ibid., 14). This tendency toward the epistemic unfolding of the universe constitutes what Kováč calls the "epistemic principle" (ibid., 14–20). According to this, but omitting the normative connotation of the word "progress," there is a general tendency toward ever more complex organisms. However, there is no teleology and no guiding principle with a clear end. What are observable are several *teleonomic* processes that simply produce complex products without any guiding foresight. The simplest teleonomic system (a self-copying molecule, for example) is already a *subject* facing the world as an object. A system (in this case a biological species) is situated in a given environment with (a) *surroundings* (the part of the environment that interacts with the system and has a detectable influence on it), and (b) an *Umwelt* (the specific part of the surroundings that interacts with the sensors of the system).[3] However, only that part of the *Umwelt* that is experienced by the subject (Husserl's *Lebenswelt*) is effectively internalised as the basis for construction(s) and operationally used as the initial input for solving problems (cf. Kováč 2007, 66). As Kováč says: "At all levels, from the simplest to the most complex, the overall construction of the subject, the embodiment of the achieved knowledge, represents its *epistemic complexity*. It is the epistemic complexity which continually increases in biological evolution, and also in cultural evolution, and gives the evolution its direction" (Kováč [2000] 2013, 17).

Coming from a completely different field of inquiry, with a background in computer science, artificial intelligence, and cognitive sciences, Subrata Dasgupta's theories on systemic and epistemic complexity open up new avenues for understanding human creativity and its tendency to continuously generate new artefacts. Whereas Kováč is focused on biological species and entities, Dasgupta's interests revolve around human-made artefacts and their origins, evolution, and epistemic content. According to Dasgupta, *artefacts* are "useful things that are produced or consciously conceived in response to some practical need, want or desire" (Dasgupta 1996, 9). But artefacts possess another

2 According to Boden and Zaw (1980, 25), "a cognitive biology would be one in which biological phenomena were conceptualized for theoretical purposes in terms of categories whose primary application is in the domain of knowledge." Moreover, according to Kováč ([2000] 2013, 1) "knowledge is embodied in constructions of organisms and the structural complexity of those constructions—which carry embodied knowledge—corresponds to their epistemic complexity" (Kováč [2000] 2013, 1).

3 The subtle differentiation between "surroundings" and "*Umwelt*" goes back to the work of Jakob von Uexküll (cf. Uexküll 1982). Jesper Hoffmeyer (2012) describes this difference as follows: "In everyday German, Umwelt means simply 'surroundings' or 'environment,' but through the work of the German biologist Jakob von Uexküll (1864–1944) the term, at least in scientific literature has acquired more specific semiotic meanings as the ecological niche as an animal perceives it; the experienced world, phenomenal world, or subjective universe; and the cognitive map or mind-set."

fundamental and interesting property, one that relates to Kováč: "like organisms, they manifest *evolution*" (Dasgupta 1997, 114). The production of "things" and their evolution over time are, therefore, central topics of his reflections. In approaching these topics, Dasgupta distinguishes *systemic complexity* from *epistemic complexity*. Referring to Herbert Simon's (1962) article "The Architecture of Complexity," Dasgupta argues that "a system ... is said to be complex if it is composed of a large number of parts or components that interact in nontrivial ways" (Dasgupta 1997, 113). Complexity depends, then, on quantitative characteristics and on intricate operational behaviours—aspects that tell us *what* the nature of an artefact is. Dasgupta calls this kind of "complexity" *systemic complexity*. It does not tell us *how* that artefact assumed the form it did, nor does it give us any clues about what it might produce in the future. The crucial claim of Dasgupta is that beyond *systemic complexity* there is another, deeper kind of complexity in the universe of human-made things: "*the richness of the knowledge that is embedded in an artifact*. I shall call this *epistemic complexity*. It consists of the knowledge that both contributes to, and is generated by, the creation of an artifact" (Dasgupta 1997, 116). Any artefact is, therefore, surrounded by knowledge that is prior to its emergence and also by knowledge that appears only after the artefact was made. In addition to these *ex-ante* and *ex-post* moments, the specific moment of invention or design is itself a knowledge-rich, cognitive process. Furthermore, artefacts themselves are also knowledge: a design embodies and encapsulates one or more operational principles, to start with. "And, in the case of true invention, when the artifactual form is *original* in some significant sense, the operational principles it encodes constitute genuinely *new* knowledge" (ibid., 117). Whereas the *systemic complexity* of an artefact requires it to be made up of a large number of parts or components that interact in complicated, non-trivial ways, *epistemic complexity* adds to it two wholly new dimensions: the artefact's capacity for producing unexpected behaviour; and the amount, variety, and novelty of the knowledge embedded in it. It is this embedded knowledge that Dasgupta calls "the epistemic complexity of an artefact" (cf. ibid., 118).

Epistemic complexity, in the sense exposed by Dasgupta, is also linked to creativity and original thinking. Even if systemic and epistemic complexity are not necessarily coupled, "epistemic complexity is entirely related to the originality of artifacts and, hence, to the *creativity* of the artificer" (Dasgupta 1997, 130). Someone doing "normal design" or working within a "mature technology" is certainly creating artefacts of potentially considerable systemic complexity; but if that system is an exercise in normal design, it will not be original but will be simple, epistemically speaking. Epistemic complexity is also avoided when the designer takes recourse in well-established styles or when a chosen style is adapted to the specific needs of the technological problem at hand. On the other hand, when the designer rejects several traditional solutions, striving for truly original configurations, knowledge may emerge in wholly surprising contexts. In such cases, "epistemic complexity is, then, a measure of the maker's creativity" (ibid., 131). However, the question of how such complexity can be assessed is not sufficiently addressed.

Dasgupta proposes the identification and enumeration of the "significant knowledge tokens" that constitute an artefact as a first step toward an evaluation of its epistemic complexity. However, as he says, the risk is that such an enumeration will stay within the limits of the artefact's *systemic complexity*, conveying "nothing of the intricacy of the interactions of these knowledge tokens, nor the manner in which they came to participate in the cognitive act, nor (in the case of old knowledge) why they were invoked at all" (ibid., 136). And here is where Rheinberger's experimental systems (and his proposed methodological reduction of systemic complexity) might be extremely useful, helping to situate better the "significant knowledge tokens" at hand. In turn, this would allow precise calibration of the diverse objects/things involved in the experimental set up and to produce graphematic outputs that allow for traceability and for the constitution of new tokens (involving epistemic gain). However, before describing Rheinberger's experimental systems, and to facilitate the understanding of its use in music performance, it is necessary to turn first to the exploration of epistemic complexity *in music*.

EPISTEMIC COMPLEXITY IN MUSIC

Musical works are highly elaborated, complex semiotic artefacts with intricate operational functions. They are made of a variable, though normally large, number of constitutive parts that interact in non-trivial ways. This gives them, in the first place, *systemic complexity*. But they are also the products of invention and embed a rich array of interconnected knowledge encapsulating one or more operational principles. Their conception, creation, and concrete making (and/or performing) inherently involve pre- and post-knowledge, as well as a vast combination of refined cognitive processes. Like organisms, they also manifest evolution (but not necessarily "progress"), doing this in three ways: (1) in terms of "pure" creation, that is, new, original compositions; (2) in terms of re-creation, that is, the performance of past musical works; (3) in the sophisticated process of their preservation over time (editions, recordings, theoretical reflections, etc.). Taking a closer look at the history of musical "things" (without adhering to traditional visions of music history, compartmentalised in styles and periods) and adapting George Kubler's statement regarding a "history of things," a "history of musical things" would include both material artefacts and aesthetic positions, both replicas and unique examples, both tools and expressions—in short all materials worked by human hands under the guidance of connected ideas developed in temporal sequence (cf. Kubler [1962] 2008, 8). New pieces are a combination of old knowledge with new cognitive extensions, and—in the most interesting cases—with unexpected and surprising elements. In addition to their systemic complexity, music things aim at producing unprecedented events embodying new knowledge. In this sense, through the amount, variety, newness, and richness of the knowledge that they embed, they have a considerable epistemic complexity, being artistic examples of what Rheinberger (talking about "experimentation" and following François Jacob) designates as "a machine to make the future" (Rheinberger 1997b, 33).

As Dasgupta writes: "Paintings, sculptures, novels, poems and plays, symphonies, fugues and ragas are all infused with epistemic complexity, especially in the intricate ways their creators summon the past and integrate it into their works" (Dasgupta 1997, 137). Just like technological artefacts, musical artefacts are characterised by systemic and epistemic complexity.

Musical works are surrounded by and encapsulated in specific epistemic settings, which are made of elaborated collections of historically produced (and inherited) "things," such as sketches, drafts, first editions, recordings, or essays concerning a given musical work. After two centuries in which the "work-concept" dominated (see, among others, Goehr [1992] 2007), in recent decades attention has turned to what may be called an *extended work-concept* that takes into consideration the deconstruction of musical works into their graspable constitutive elements, revealing them as complex accumulations of singularities and as multi-layered conglomerates of "things" with the utmost diversity (cf. Kramer 2011, chapters 11 and 14). The closer one gets to such constitutive things, the clearer the epistemic complexity of musical works and performances becomes.

From the perspective of a performer dealing with a musical work from the past (which might also be a very recent past), types of relevant objects loaded with variable degrees of epistemic complexity include:

1 Materials generated by the composer (sketches, drafts, manuscripts, first prints, revisions of prints, etc.)
2 Editions of a "piece" throughout time
3 Recordings of works
4 The reflective and conceptual (musicological, philosophical, analytical, etc.) apparatus around musical works (including thesis, articles, books, etc.)
5 The organological diversity; that is, the musical instruments in use (for example, historical versus contemporary)
6 The performative/aesthetic "orientation" of the performer (historically informed practice, "Romantic interpretation," "new objectivity," "modernising approach," etc.)
7 Arrangements of works
8 The practitioner's own body, which is biologically, technically, and culturally organised

One important observation is that until quite recently many of the items in this list were not generally available since they were the "property" of an exclusive group of experts. In the current, increasingly democratised knowledge-society more and more people have access to them. The items on the list are just the main tokens of a musical work's epistemic complexity and may be extended by potentially infinite further sub-tokens. They build a complicated network of things with embedded knowledge. At some point, they all were reifications or sedimentation of a specific creative or reflective situation. Now, they might function as (1) objects of inquiry (What are they? How many parts do they have? How do they function?) or as (2) "things" for further inquiries (How can they become productive again? How can they build reconfigurations of the work they belong to? What futures do they enhance?). The first approach has to do with a work's systemic complexity, the second with its epistemic complexity.

Moreover, making explicit the epistemic complexity of musical works allows us to understand works as made up of a myriad of "boundary objects" (see also Star and Griesemer 1989). To make performances using selections of such "boundary objects" is an act that discloses open-ended possibilities for new assemblages. Crucial to these new assemblages—and necessary to enhance their epistemic complexity—is the inclusion of a productive "not-yet-knowing," the creation of room for what is yet unthought and unexpected. Under this light, processes of *becoming* appear as more productive than statements of *being*. Works, just like "objects of knowledge," in general remain essentially open. The fundamental incompleteness of any attempt to "close" or narrow down a human-made invention becomes the starting point for epistemic games. As Knorr Cetina (2001, 181) states: "I want to characterize objects of knowledge ('epistemic objects') in terms of a lack in completeness of being that takes away much of the wholeness, solidity, and the thing-like character they have in our everyday conception." In the place of a clear-cut ontology of the artwork, we find an unfolding becoming, where experimentation and the concrete production of new incomplete assemblages become the central artistic activity.

HANS-JÖRG RHEINBERGER'S *EXPERIMENTAL SYSTEMS*

Rheinberger developed his theory of "experimental systems" in relation to the empirical sciences, particularly to molecular biology. However, it was Rheinberger himself who opened the door for other potential uses of this theory, specifically, for example, in relation to the activity of writing: "Das Schreiben, so behaupte ich, ist selbst ein Experimentalsystem" (Rheinberger 2007, my translation; Writing, so I claim, is an experimental system in its own right). That Rheinberger mentions "writing" [Das Schreiben] as a potential field for applications of his theory has certainly to do with his conception of the experimental space and of the scientific object itself as a complex "bundle of inscriptions" (Rheinberger 1997b, 111). The idea of "inscription" might be traced back to Derrida, whose seminal book *De la grammatologie* [*Of Grammatology*] Rheinberger translated into German (with Hanns Zischler) in 1983. Taking his own suggestions further, I propose to extend the use of his theory also to the performance of past musical works.

In the prologue to his book *Toward a History of Epistemic Things*, Rheinberger stresses that "in a post-Kuhnian move away from the hegemony of theory, historians and philosophers of science have given experimentation more attention in recent years" (Rheinberger 1997b, 1). Reflecting that, Rheinberger's essay is "an attempt at an epistemology of contemporary experimentation based on the notion of 'experimental system'" (ibid.). Originally taken from the everyday practice and vernacular of mid-twentieth-century life scientists, the concept of "experimental system" is frequently used, as in Rheinberger, to characterise the space and scope of the research activities conducted by researchers in those sciences (particularly in biochemistry and molecular biology). Importantly, this is, in the first place, a practitioner's notion, not an observer's (see Rheinberger

1997b, 19). In his most succinct formulation, Rheinberger states that "experimental systems are arrangements that allow us to create cognitive, spatiotemporal singularities" (ibid., 23). And in a later publication Rheinberger writes, "It is only at the beginning of the 1990s and in the context of an ongoing replacement of theory-dominated perspectives of scientific change by practice-driven views on research that the concept of experimental systems has found entrance into the historical and philosophical literature on science (Rheinberger 1992, Rheinberger and Hagner 1993, Rheinberger 1997[b])" (Rheinberger 2004, 2).

Rheinberger, himself a molecular biologist and a philosopher, developed "a framework in which experimentation takes meaning as a set of epistemic practices that constitute a specific kind of material culture" (Rheinberger 1997b, 19). On several occasions—notably in the "Prologue" to the book *Toward a History of Epistemic Things* and in the online essay "Experimental Systems: Entry Encyclopedia for the History of Life" (Rheinberger 2004)—Rheinberger gives a thorough description of the four basic features of an experimental system. These features are summarised in table 1.

(a) Working units of contemporary research	—"Experimental systems … are the genuine working units of contemporary research in which the scientific objects and the technical conditions of their production are inextricably interconnected. They are, inseparably and at one and the same time, local, individual, social, institutional, technical, instrumental, and, above all, epistemic units. Experimental systems are thus impure, hybrid settings" (Rheinberger 1997b, 2).
(b) Differential reproduction	—"Experimental systems must be capable of differential reproduction … in order to behave as devices for producing scientific novelties that are beyond our present knowledge, that is, to behave as 'generator[s] of surprises.'… To be productive, experimental systems have to be organized in such a way that the generation of differences becomes the reproductive driving force of the whole experimental machinery" (Rheinberger 1997b, 3). —"Differential reproduction conveys a peculiar kind of historicity to experimental systems. They can acquire, to speak with Ian Hacking 'a life of their own'" (Rheinberger 2004, 5, including citation of Hacking 1983, 215).
(c) Graphematicity	"Experimental systems are the units within which the signifiers of science are generated. They display their meanings within spaces of representation … in which graphemes, that is, material traces … are produced, articulated, and disconnected and are placed, displaced, and replaced. … scientists create spaces of representation through graphematic concatenations that represent their epistemic traces as engravings, that is, generalized forms of 'writing'" (Rheinberger 1997b, 3).
(d) Experimental cultures – conjunctures – bifurcations – hybridisations	—"Experimental systems get linked into experimental ensembles, or experimental cultures … [through] conjunctures and bifurcations" (Rheinberger 1997b, 3). —"Finally, conjunctures and ramifications of experimental systems can lead to ensembles of such systems, or experimental cultures." (Rheinberger 2004, 6).

Table 1: The four basic features of experimental systems.

In short, an experimental system is a specific unit of research, spatiotemporally precisely located, wherein two kinds of "things" interact: technical objects and epistemic things (whose difference is functional and not ontological). Within such a system, mechanisms of reproduction and repetition aim at the generation of differences. Furthermore, an experimental system is a space of representation where inscriptions are made in order to generate and preserve traces. Finally, experimental systems might establish links to other experimental systems (conjunctures), be divided into several experimental systems (bifurcations), or merge with other experimental systems (hybridisation). At some point an articulation of ensembles of experimental systems might emerge, generating what Rheinberger calls "experimental culture" (cf. Rheinberger 1997b, 3).

Rheinberger's use of the term "system" has nothing to do with Luhmann's "systems-theory," nor with other hermetic or closed systems such as Maturana and Varela's "autopoeisis." As Rheinberger states: "'System' means here simply a kind of loose coherence both synchronically with respect to the technical [objects] and organic [epistemic] elements that enter into an experimental system and diachronically with respect to its persistence over time" (Rheinberger 2004, 3). As the use of the terms "technical object" and "epistemic elements" reveals, *technicity* and *epistemicity* form an intricate relation at the inner core of an experimental system. "Epistemic things" are the entities "whose unknown characteristics are the target of an experimental inquiry" (Rheinberger 1997b, 238), paradoxically embodying what one does not yet know (cf. ibid., 28). "Technical objects" (sedimentations of earlier epistemic things) are scientific objects that "embody the knowledge of a given research field at a given time" (ibid., 245); they might be "instruments, apparatus, and devices which bound and confine the assessment of the epistemic things" (Rheinberger 2004, 4). Epistemic things are necessarily underdetermined, while technical objects are characteristically determined. Technical objects and epistemic things coexist simultaneously within the experimental system, and "whether an object functions as an epistemic or a technical entity depends on the place or 'node' it occupies in the experimental context" (Rheinberger 1997b, 30); "within a particular research process, epistemic things can eventually be turned into technical things and become incorporated into the technical conditions of the system" (Rheinberger 2004, 4). Between the two extremes, there is room for a gradient scale, for diverse degrees of hybrid things and for vague material entities whose function in the experimental system changes. An example of such an entity, when applying these notions to music, is the score, the material inscription of a complex set of signs and symbols that might be considered as either an epistemic thing or a technical object depending on the role it plays at any particular point during a performance.

Experimentation in Music Performance: How to Make the Future?

The application of Rheinberger's terminology and research architecture to music performance is an attempt to establish a wider common ground for

artistic research in music performance. This application is not obvious, nor is it straightforward. Rheinberger developed his theories in a very specific field of inquiry. In transferring these theories to other fields (especially to artistic and creative areas), one must proceed cautiously. This said, however, there are several musical entities that might be considered as being "technical objects" and/or "epistemic things," depending on the specific use and context of their presentation. Accepting the risk incurred in applying Rheinberger's theories to music, one might say that scores, instruments, or tuning systems, for instance, may be seen as technical objects that are brought into particular constellations (such as "the concert" or a CD recording), to produce art. The same entities may, however, operate as epistemic things, whose qualities can be divided into two main groups: those already known and those still to be known (discovered). Musical works participate, therefore, in two different worlds: one related to their past (what constitutes them as recognisable objects), another related to their future (what they might become). If we require the performance to be an idealised act of interpretation (be it hermeneutic or performative[4]) and if we reduce it to the repetition of the score (understood as an instrumental technical object), we take away the possibility for epistemic things to emerge or to unfold into unforeseen dimensions. We would be dealing mainly with the work's past. If we want to give credibility to performance as an instance, among others, of epistemic activity, we need a concept such as "experimentation" that creates space in relation to the score (which would otherwise overdetermine and close down the epistemic potential of performance practice), allowing unpredictable futures to happen. And we also need Rheinberger's experimental systems as a basic methodological tool to frame our artistic experimental approach.

From this perspective, experimentation, methodologically conducted through experimental systems, might allow for "making the future" of past musical works, something of which "interpretation" is far less capable. Moreover, artistic experimentation has the potential to bring together the past and the future of "things," enabling and concretely building (constructing) new assemblages—something that non-artistic modes of knowledge production cannot do.

But how can such new assemblages appear? Under what conditions and responding to which criteria? How to evaluate their quality? How to assess their constitutive parts and define them as contributions to knowledge? To suggest possible lines of answer to these questions a brief summary of the concepts and practices exposed so far in this chapter—as well as a reference to the Foucauldian concepts of *archaeology* and *problematisation*—will help better situate and explain not only the concept of "experimentation" in use in this chapter but also my own conception of artistic research and its role in our knowledge society.

The first fundamental concept presented in this chapter was that of *epistemic complexity* as defined and developed by Kováč and Dasgupta. For Kováč epistemic complexity is the result of the epistemic unfolding of the universe (*epis-*

4 For the distinction between hermeneutic and performative "interpretation" see Hermann Danuser's entry on "Interpretation" for the German Encyclopaedia MGG (Danuser 2007).

temic principle), while for Dasgupta it concerns the richness of the knowledge that is embedded in an artefact. If we think in terms of simple time coordinates such as past-present-future these two perspectives share one characteristic: they both scrutinise things (biological organisms or human-made artefacts), looking at and analysing their respective pasts. What things *are* in the present is understood to be an accumulation of epistemic features throughout time, from the past until the present. Even if this approach might inform us how an organism or an artefact might behave in the near future, the main concern of those two authors is not with the future but with identifying, articulating, and evaluating the evolution of such things.

Second, I presented the concept of *things* as developed by Rheinberger, inspired by Kubler. This concept allowed me to consider the epistemic complexity of the natural and human worlds as a potentially infinite galaxy of things, entities that escape closed definitions and that might have different functions according to the context in which they are temporarily immersed. In the second section I mentioned some graspable examples of things that constitute musical works, things that I defined as tokens of a musical work's epistemic complexity. This breakdown of the epistemic complexity of musical works into its manifold constitutive elements (things) is crucial because it enables open-ended possibilities for new assemblages.

In this constellation of potentially infinite things the concept of *archaeology*, as elaborated by Michel Foucault, becomes a helpful methodological tool. According to Clare O'Farrell, "'Archaeology' is the term Foucault used during the 1960s to describe his approach to writing history. Archaeology is about examining the discursive traces and orders left by the past in order to write a 'history of the present.' In other words archaeology is about looking at history as a way of understanding the processes that have led to what we are today" (O'Farrell 2007). In this sense, archaeology is a way to look at the past from the present, with the goal of better situating/understanding the present (and, crucially, *not* the past). It describes a boomerang-like route: from the present to the past, and back from the past to the present. It does not aim at disclosing "how things really were" but rather "why things are what they are" *today*. In Foucault's words:

> Archaeology does not try to restore what has been thought, wished, aimed at, experienced, desired by men in the very moment at which they expressed it in discourse... it does not try to repeat what has been said by reaching it in its very identity. It does not claim to efface itself in the ambiguous modesty of a reading that would bring back, in all its purity, the distant, precarious, almost effaced light of the origin. It is nothing more than a rewriting: that is, in the preserved form of exteriority, a regulated transformation of what has already been written. It is not a return to the innermost secret of the origin; it is the systematic description of a discourse-object. (Foucault 1972, 139–40)

The link to Michel Foucault is explicit in Rheinberger and is very important to his theories of experimental systems in several regards but particularly to the definition of epistemic thing: "[Foucault's] 'discourse-object' is what I call an epistemic thing" (Rheinberger 1997b, 8). For Rheinberger, epistemic things are

"things embodying concepts" that "deserve as much attention as generations of historians have bestowed on disembodied ideas" (ibid.). To give epistemic things the attention they deserve is (1) to extract them out of the *chaos* of systemic complexity, and (2) to allow them to contribute to the formation of new entities, new epistemic things that, in turn, will add new things to the archaeology of epistemic things, that is, to epistemic complexity. From this perspective, archaeology appears almost as a necessary consequence of epistemic complexity.

But Foucault's "discourse-object" is not only to be described but must be productively resituated, involving *problematisation*, another Foucauldian concept that gained increased relevance in Foucault's late works: "The notion common to all the work that I have done since *Histoire de la Folie* is that of problematization." (Foucault 1998, 257). With this concept Foucault refers to the work one does to direct one's thought toward present practices which were once seen as stable but which the researcher shows to be problematic in some crucial sense.

> Problematization doesn't mean the representation of a pre-existent object, nor the creation through discourse of an object that doesn't exist. It is the totality of discursive or non-discursive practices that introduces something into the play of the true and false and constitutes it as an object for thought. (Foucault 1998, 257)

Problematisation has, therefore, to do with "objects," with things that are archaeologically retraced and transmuted from "neutral objects" into "objects for thought." In the context of the present chapter, archaeology and problematisation go hand-in-hand, and they both work as problematisation of the *aesthetic-epistemic complexity* described above.

Epistemic complexity, *things*, *archaeology*, *problematisation*—the concepts presented so far—all scrutinise things (biological organisms, human-made artefacts, and concepts) by enquiring into their past. The notion of problematisation might be understood as a highly elaborated form of *interpretation* of historical data. In this sense, looking backwards and applied to music, it is perfectly recognisable in disciplines such as, for example, music analysis, music theory, music historiography, organology, and biographical studies—in fact in the majority of musicological sub-disciplines.

However, there might be a different mode of problematising things, a mode that, rather than aiming to retrieve what things *are*, searches for new ways of productively exposing them. That is to say, a mode that, instead of critically looking into the past, creatively projects things into the future. Such is the final proposal of this chapter: to reverse the perspective from "looking into the past" to creatively designing the future of past musical works. In my view this is precisely what artistic research could be about—a creative mode that brings together the past and the future of things in ways that non-artistic modes cannot do. In doing this, artistic research must be able to include archaeology, problematisation, and experimentation in its inner fabric. The making of artistic *experimentation* through Rheinberger's *experimental systems* becomes a creative form of *problematisation*, whereby through *differential repetition* new assemblages of things are materially handcrafted and constructed.

In a deeper sense experimentation is not the act of conducting experiments (and even less of making tests). Aesthetic experimentation relates primarily to a completely new orientation of the senses and of the reason, aiming to reconfigure the sensible. As phrased by Ludger Schwarte in the opening speech of a conference on "experimental aesthetics" held in Düsseldorf in 2011: "Aesthetic experimentation starts when the parameters of a given aesthetic praxis are broken, suspended, or transcended, in order to work out a particular mode of appearance that reconfigures the field of the visible and of the utterable" (Schwarte 2012, 187, my translation).[5]

That such reconfigurations are only possible after a profound consideration of the epistemic complexity of aesthetic things is the inevitable and necessary condition for creative problematisation; that is to say: for artistic research. From this perspective, artistic research therefore happens when: (1) The epistemic complexity of a given object of inquiry is scrutinised; (2) the constitutive things of such objects of inquiry are identified and isolated; (3) an archaeology of such things is explored; (4) the results of this exploration are problematised with the purpose of enabling their projection into the future; (5) the problematisation happens in precisely calibrated frameworks (experimental systems); (6) inside an experimental system *differential repetition* is stimulated, enhanced, and achieved; (7) new assemblages of things emerge as the result of a constructive (and not only theoretical) endeavour.

5 "Das ästhetische Experimentieren beginnt dort, wo die Parameter einer gegebenen ästhetischen Praxis unterbrochen, suspendiert oder überschritten werden, um eine spezifische Erscheinungsform herauszuarbeiten, die das Feld des Sichtbaren und Sagbaren rekonfiguriert."

REFERENCES

Boden, Margaret A., and Susan Khin Zaw. 1980. "The Case for a Cognitive Biology." *Proceedings of the Aristotelian Society, Supplementary Volumes* 54: 25–49 + 51–71.

Borgdorff, Henk. 2012. "Boundary Work: An Interview." Chapter 8 in *The Conflict of the Faculties: Perspectives on Artistic Research and Academia*, 174–83. Leiden: Leiden University Press.

Brown, Bill. 2001. "Thing Theory." *Critical Inquiry* 28 (1): 1–22.

Danuser, Hermann. 2007. "Interpretation." In *Musik in der Geschichte und Gegenwart: Allgemeine Enzyklopädie der Musik*, edited by Friedrich Blume and Ludwig Finscher, 2nd ed., 21 vols., 1994–2007, 3:1053–69. Kassel: Bärenreiter; Stuttgart: Metzler.

Dasgupta, Subrata. 1996. *Technology and Creativity*. New York: Oxford University Press.

———. 1997. "Technology and Complexity." *Philosophica* 59: 113–39.

Derrida, Jacques. 1976. *Of Grammatology*. Translated by Gayatri Chakravorty Spivak. Baltimore: Johns Hopkins University Press. First published 1967 as *De la grammatologie* (Paris: Éditions de Minuit).

Foucault, Michel. 1972. *The Archaeology of Knowledge*. Translated by A. M. Sheridan Smith. New York: Pantheon Books. First published 1969 as *L'archéologie du savoir* (Paris: Gallimard).

———. 1998. *Politics, Philosophy, Culture: Interviews and other Writings, 1977–1984*. Edited by Lawrence D. Kritzman, translated by Alan Sheridan et al. London: Routledge.

Gieryn, Thomas F. 1983. "Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists." *American Sociological Review* 48 (6): 781–95.

Goehr, Lydia. (1992) 2007. *The Imaginary Museum of Musical Works: An Essay in the Philosophy of Music*. Rev. ed. New York: Oxford University Press.

Hacking, Ian. 1983. *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press.

Hoffmeyer, Jesper. 2012. "Umwelt." In *Encyclopedia of Semiotics*, edited by Paul Bouissac. Oxford University Press, 2007–. Article published 15 June. Accessed 10 June 2013. http://www.oxfordreference.com/view/10.1093/acref/9780195120905.001.0001/acref-9780195120905-e-290?rskey=DbH3VO&result=290&q=.

Knorr Cetina, Karin, 2001. "Objectual Practice." In *The Practice Turn in Contemporary Theory*, edited by Theodore R. Schatzki, Karin Knorr Cetina, and Eike von Savigny, 175–88. London: Routledge

Kováč, Ladislav (1986). "Úvod do kognitívnej biológie" [Introduction to cognitive biology]. *Biologické listy* 51: 172–90; includes an abstract in English.

———. (2000) 2013. "Fundamental Principles of Cognitive Biology." *Evolution and Cognition* 6: 51–69. Republished online by Bratislava Biocenter, no date. Accessed 21 May 2013. www.biocenter.sk/lkpubcogbiol_files/c-7.pdf. Page references are to the Bratislava Biocenter edition.

———. 2007. "Information and Knowledge in Biology: Time for Reappraisal." *Plant Signaling & Behavior* 2 (2): 65–73.

Kramer, Lawrence. 2011. *Interpreting Music*. Berkeley: University of California Press.

Kubler, George. (1962) 2008. *The Shape of Time: Remarks on the History of Things*. New Haven, CT: Yale University Press.

Kuhn, Hans. 1972. "Selbstorganisation molekularer Systeme und die Evolution des genetischen Apparats." *Angewandte Chemie* 84 (18): 838–62.

Kuhn, Hans. 1988. "Origin of Life and Physics: Diversified Microstructure—Inducement to Form Information-Carrying and Knowledge-Accumulating Systems." *Journal of Research and Development* 32 (1): 37–46.

O'Farrell, Clare. 2007. "Key Concepts." Michel-Foucault.com. Accessed 22 April 2013. http://www.michel-foucault.com/concepts/.

Rheinberger, Hans-Jörg. 1992. *Experiment, Differenz, Schrift: Zur Geschichte epistemicher Dinge*. Marburg an der Lahn: Basilisken-Presse.

———. 1997a. "Experimental Complexity in Biology: Some Epistemological and Historical Remarks." In "Proceedings of the 1996 Biennial Meetings of the

Philosophy of Science Association; Part 2: Symposia Papers," supplement, *Philosophy of Science* 64: S245–S254.

———. 1997b. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

———. 2004. "Experimental Systems: Entry Encyclopedia for the History of the Life Sciences." *The Virtual Laboratory: Essays and Resources on the Experimentalization of Life*, Max Planck Institute for the History of Science, Berlin. Accessed 09 May 2013. http://vlp.mpiwg-berlin.mpg.de/essays/data/enc19?p=1.

———. 2007. "Man weiss nicht genau, was man nicht weiss: Über die Kunst, das Unbekannte zu erforschen." *Neue Zürcher Zeitung*, 5 May. Accessed 5 December 2012. http://www.nzz.ch/aktuell/startseite/articleELG88-1.354487.

Rheinberger, Hans-Jörg, and Michael Hagner. 1993. "Experimentalsysteme." In *Die Experimentalisierung des Lebens: Experimentalsysteme in den biologischen Wissenschaften, 1850 / 1950*, edited by Hans-Jörg Rheinberger and Michael Hagner, 7–27. Berlin: Akademie.

Schwarte, Ludger. 2012. "Experimentelle Ästhetik: Arbeit an den Grenzen des Sinns." *Zeitschrift fur Ästhetik und Allgemeine Kunstwissenschaft* 57 (2): 185–95.

Simon, Herbert A. 1962. "The Architecture of Complexity." *Proceedings of the American Philosophical Society* 106 (6): 467–82. Reprinted 1996 in Herbert A. Simon, *The Sciences of the Artificial*, 3rd ed., 183–216 (Cambridge, MA: MIT Press).

Star, Susan Leigh, and James Griesemer. 1989. "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39." *Social Studies of Science* 19 (3): 387–420.

Uexküll, Jakob von. 1982. "The Theory of Meaning." In an untitled special issue, edited by Thure von Uexküll, translated by Barry Stone and Herbert Weiner, *Semiotica* 42 (1): 25–82. Special issue devoted to J. von Uexküll's *Bedeutungslehre* (Leipzig: Barth, 1940).

Criticism and Experimental Systems

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"How is Pure Natural Science Possible?" Kant asks in the second part of the *Prolegomena* (1783) (Kant 2004, 46). The key to his answer is the distinction between a posteriori judgements that are "merely subjective, if representations are related to one consciousness in one subject alone and are united in it," and a priori judgements that are "objective, if they are united in a consciousness in general, i.e., are united necessarily therein" (ibid., 56). Scientific knowledge, which for Kant is knowledge *tout court*, is constituted exclusively by a priori judgements, so that the question becomes, essentially, how necessary and universal judgements can derive from contingent and particular judgements. Kant concludes that "the principles by means of which all appearances are subsumed under these concepts form a psychological system, i.e., a system of nature, which precedes all empirical cognition of nature and first makes it possible, and can therefore be called the true universal and pure natural science" (ibid., 57–8).

The "transcendental deduction" from phenomena to conditions of possible experience is not only at the core of Kant's critique of metaphysics and justification of empirical science in the *Critique of Pure Reason*, but also forms the main strategy of argumentation pursued in the other two *Critiques* (Förster 1989). About judgements of taste, Kant asks in the *Critique of Judgement* (1790): "How is a judgment possible which, merely from *one's own* feeling of pleasure in an object, independent of its concept, judges this pleasure, as attached to the representation of the same object *in every other subject*, a priori, i.e., without having to wait for the assent of others?" (Kant 2000, 168–69, typography regularised). The details of Kant's standard answer,[1] its interpretation, and problematic relation to transcendental deduction are beyond the scope of this paper. What is crucial here is Kant's formulation of the third *Critique*'s main question and the necessary relation it posits between aesthetic judgement and a priori knowledge. Further, by throwing a bridge between the realms of subjective "freedom" and objective "nature,"[2] Kant also assigns to criticism

1 See, for instance, "Deduction of Judgments of Taste" (Kant 2000, 170–71) and sections nine and twenty-two of "Analytic of the Beautiful" (Kant 2000, 102–4, 123–27).

2 See Introduction IX, "On the Connection of the Legislations of Understanding and Reason through the Power of Judgment" (Kant 2000, 80–83).

the paradoxical project that characterises its entire historical development to the present: finding a priori validity for its propositions, as the opening of Rosalind Krauss's *The Originality of the Avant-Garde* (1985) perfectly illustrates.[3] At the round table "The Present Condition of Art Criticism" convened for the one-hundredth issue of *October*, Krauss recognises a moment of discontinuity in critical discourse (Baker et al. 2002, 204) and over the next decade, a debate upon the "crisis of criticism" (Berger 1998; Rubinstein 2003) spreads across the discipline, before disappearing quietly, almost without a trace (Elkins 2010). This debate is but the latest in a series of recurring cycles of a crisis overcoming criticism (e.g., Kaplan 1948; De Man 1967) and "new criticisms" emerging in response (e.g., Ransom 1941; Morris 1972), without any interest in its history and epistemology being sustained, any agreement upon its methodologies being reached, or any of its ontologies being taken too seriously.

Given the near absence of historiography, the crisis of criticism cannot be conclusively attributed to a paradigmatic shift. Nevertheless, since the *October* round table in 2002, empirical research seems to have intensified at the borders of criticism with other disciplines, effectively expanding its discourse.[4] This process of disciplinary colonisation and creolisation of criticism responds to long-disregarded expectations for greater objectivity and social engagement (Eagleton 1984) but is incompatible with the Kantian paradigm outlined above. The end of the Culture Wars and the restructuring of higher education in Europe (Bologna Process) in the late 1990s facilitated an unprecedented application of scientific practices, techniques, and technologies to objects previously believed to be exclusive to critical enquiry. In this expansion of experiment-driven research into criticism, of which the new field of eHumanities is particularly illustrative, epistemologies of experimentation offer a valid alternative to the received epistemologies of criticism founded on psychological, historical, politico-economical, or linguistic a prioris.

The interest of criticism in New Experimentalism (Mayo 1994) and Hans-Jörg Rheinberger's experimental systems is fairly recent, but the connection with experimentation actually predates the Kantian paradigm and, for instance, is already discernable in the Abbé Dubos's influential *Réflexions critiques sur la poésie et sur la peinture* of 1719. *Réflexions critiques*, which also introduces the "system of the arts" into criticism,[5] is instrumental in David Hume's attempt to integrate

3 "Can it be argued that the interest of critical writing lies almost entirely in its method? Can it be held that the content of any given evaluative statement—'this is good, important,' 'this is bad, trivial'—is not what serious criticism is, seriously, read for? But rather, that such criticism is understood through the forms of its arguments, through the way that its method, in the process of constituting the object of criticism, exposes to view those choices that precede and predetermine any act of judgement" (Krauss 1985, 1).

4 Without claiming to be exhaustive, a few representative examples can be organised in six groups: (1) Cognitive aesthetics in psychology (Schellekens and Goldie 2011), in neuroscience (Chatterjee 2011), in evolutionary anthropology (Dutton 2009; Gotschall 2012), and in cultural anthropology (Davis 2011); (2) Sociology of art (Tanner 2003; De la Fuente 2007); (3) Art history and cultural studies (Latour and Weibel 2002; Elkins 2003, 2008; Belting 2003; Sachs-Hombach 2005; Probst and Klenner 2009; Frank and Lange 2010); (4) Cultural politics and law (Groys 2008; Throsby 2010; Nafziger, Paterson, and Renteln 2010; Nafziger 2012); (5) Art business and management (Frey 2003; Velthuis 2005; Towse 2010; Horowitz 2011); (6) Computer science and technology (Schreibman, Siemens, and Unsworth 2004; Manovich 2012; Moretti 2005).

5 Here I am simplifying: Charles Batteux's 1746 treatise *Les Beaux-arts réduits à un même principe* (The fine arts reduced to a single principle) is usually credited for introducing the system of the arts, but Dubos anticipates it according to Mace (1997).

criticism into experimental philosophy, within his wider programme of turning the Cartesian system of knowledge upside down.[6] In Descartes's simile from *The Principles of Philosophy* (1647), "The roots are metaphysics, the trunk is physics, and the branches emerging from the trunk are all the other sciences, which may be reduced to three principal ones, namely medicine, mechanics and morals," which "presupposes a complete knowledge of the other sciences and is the ultimate level of wisdom" (Descartes 1985, 186). In contrast, the tree in Hume's *A Treatise of Human Nature* ([1739–40] 1961) has the "Science of Man" (psychology) as its trunk, from which understanding and passions branch out, corresponding to the content of the first two books. Sciences on the first branch are classified according to the relations between their ideas—mathematics, natural philosophy (including anatomy), and natural religion; sciences on the other branch are classified according to the relation of the passion with its cause—morals, criticism, and politics, with logic connecting the two branches (modified from Hazony 2009). Perception becomes Hume's "true Metaphysics" (Hume [1748] 1975, 12), and the entire science of man including criticism must thus be rooted in "observations and experiment."[7]

Introducing experimental systems, Rheinberger clearly distinguishes them from eighteenth-century philosophical and natural systems,[8] yet they share much in common with "experimental philosophy" (Anstey and Vanzo 2012) in reacting to aprioristic epistemologies, such as those of Popper or Descartes.[9] In the context of what Jonathan Israel (2001) terms "Radical Enlightenment," two oppositions historically define Hume's "compleat system of sciences": at the one end, that of Descartes's speculative philosophy; and at the other, that of Kant's transcendental philosophy. From this second opposition a fault line

6 Thomas Huxley (1879, 11) commented that Hume "ruthlessly pruned away" the tree of philosophy and left "a pretty shrub enough."

7 "We must ... glean up our experiments in this science from a cautious observation of human life, and take them as they appear in the common course of the world, by men's behaviour in company, in affairs, and in their pleasures. Where experiments of this kind are judiciously collected and compared, we may hope to establish on them a science which will not be inferior in certainty, and will be much superior in utility to any other of human comprehension" (Hume [1739–40] 1961, 1:7–8).

8 For instance, in this passage: "In all these theoretical systems, their protagonists integrated observations and sporadically also experiments as additional arguments and evidences in favor of these systems. These observations and experiments, as a rule, were however not the driving forces for the establishment of the systems. At best, they strengthened their credit and plausibility. Two hundred years later, the situation is just the other way round. The guarantee for scientific coherence has been put upside down. *Experimental* systems—that is, material contrivances—govern the research fields, into which theories and concepts have to be fitted, at least if they want to earn scientific credit and have a real influence on a particular research trajectory" (Rheinberger 2011). As examples of eighteenth-century systems Rheinberger quotes Linné's categorial *Systema naturae* (1735) that Hume knew at least through Buffon; the "system of the earth" in Comte de Buffon's *The System of Natural History* (1749), of which Hume had at least two volumes in his library (Hume [1766] 1932, 2:82); the "system of the eggs" and "of the animalcules" in the *Système de la nature* (1751) by Maupertuis, where some mutual influence has been proved (Mossner 1980, 322; Malherbe 2005, 72–73; Knox-Shaw 2008); the *System of Nature* (1770) by Hume's friend and translator Baron d'Holbach (Hume [1769] 1932, 2:205; Mossner 1980, 475–76). William Harvey's "venous system" in the *Exercitatio anatomica de motu cordis et sanguinis in animalibus* of 1628 (Harvey 1970, 114) and Isaac Newton's "system of the world," the third book of the *Philosophiae naturalis principia mathematica* (Newton 1999), are additions to Rheinberger's list of particular significance to Hume's *Treatise*.

9 For a comment on Popper, see Rheinberger (1992, 24n13). Rheinberger also identifies with "non-Cartesian epistemology" (Bachelard 1984, chapter 6, quoted in Rheinberger 1995, 110). For Popper's "recontextualisation within a Kantian tradition," see Naraniecki 2010.

in criticism, dividing a posteriori and a priori paradigms, can be traced to the present day. On one side, because Hume's aesthetic judgements depend on a (complex) causal relation arising from aesthetic experience, the science of criticism is "experimental" and expands towards psychology and socio-historical fields.[10] For Kant, on the other side, Hume's are only synthetic a posteriori judgements that do not constitute scientific knowledge.[11] Therefore, aesthetic judgements must precede, logically if not temporally, aesthetic experience (Kant 2000, 102–4) and be a priori grounded on "the play of the cognitive powers of the subject" (ibid., 107).

On several occasions, Rheinberger defines his experimental systems by characterising their structure, functionality, dynamics, and evolution:

> First, such systems are the smallest integral working units of research. ... Second, experimental systems must be able to undergo series of differential reproductions, if they are to remain arrangements for the production of new bits of knowledge that lie beyond what one is actually able to conceive of and to anticipate. ... Third, experimental systems are those units within which the material signifying units of knowledge are produced. ... Fourth, and finally, conjunctures and ramifications of experimental systems can lead to ensembles of such systems, or experimental cultures. (Rheinberger 2004, 4–6)

In the next four sections, I will endeavour to examine each characteristic by cross-reading Rheinberger's experimental systems and Hume's science of criticism. This will enable me to explore the historical beginnings of experiment-driven research in criticism and to highlight some of its issues, already identifiable in Hume's main essay on criticism.

UNIT OF RESEARCH

"Of the Standard of Taste" (Hume [1757] 1993), published in *Four Dissertations* (1757) together with the related "Of Tragedy," is Hume's only and last word on criticism, completing the plan laid out almost twenty years earlier (Hume [1739–40] 1961, 1:2). In his tree of knowledge, criticism is midway between morals and politics, and between its two distinct historical influences: philosophical sentimentalism and social characterisations of taste in the first three-quarters of the seventeenth century.

As Shaftesbury ([1714] 1999, 179–80) had done before him, Francis Hutcheson, in the first book of *An Inquiry into the Original of Our Ideas of Beauty and Virtue* (1725), identifies among other inner senses (Hutcheson [1725] 2008, 25) "a natural power of perception or sense of beauty in objects, antecedent to all custom, education or example" (ibid., 70). Hume unifies Hutcheson's inner senses into a single sense responsible for both moral and aesthetic beauty (Hume [1739–40] 1961, 2:312). From this beauty he derives two complementary

10 For the first aspect, see "Of the Delicacy of Taste and Passion" (Hume [1741–42] 1993). For the second, see "Of the Rise and Progress of the Arts and Sciences" (Hume [1742b] 1993), "Of Refinement in the Arts" (Hume [1752] 1993), and Cunningham 2004.

11 See how Kant "dispose[s] thoroughly of the Humean doubt" in the *Prolegomena* (Kant 2004, 62).

characteristics: first, in relation to its causes it is a mode, a dispositional unity of the ideas produced through the imagination by the impressions of an object (ibid., 1:24); second, in relation to self it is a calm passion, which those ideas produce when their reflective impression on the inner sense (sentiment) is accompanied by cognitive pleasure (ibid., 2:24–5). Since pleasure is the defining characteristic of beauty, criticism is the empirical science that studies its causes from its observable effects, that is, judgements of taste.[12]

On the other hand, it is the politics of taste that drives the discourse from the very beginning, as Joseph Addison's article for the *Spectator* (no. 409, 19 June 1712) shows:

> Gratian very often recommends the fine taste, as the utmost perfection of an accomplished man. As this word arises very often in conversation, I shall endeavour to give some account of it, and to lay down rules how we may know whether we are possessed of it, and how we may acquire that fine taste of writing, which is so much talked of among the Polite World. (Addison [1712] 1854, 6:315)

This quotation refers to Baltasar Gracián's *El Oráculo manual y arte de prudencia* (1647), anonymously translated into English from the French translation as *The Courtiers Manual Oracle; or, The Art of Prudence* (London 1685). While Pierre Bourdieu (1984) reduces taste to power and George Dickie (1996) chooses to ignore its political dimension altogether, Hans-Georg Gadamer correctly points out, in *Truth and Method*, how from Italian courtly ideals and humanistic conceptions of *Bildung* (cultivation) *el gusto* develops into a distinctive "mode of knowing," structuring the good society (Gadamer [1989] 2004, 32). In this tradition, the bourgeois public sphere that emerges in Britain after the Restoration institutes criticism with a censoring function of morals and taste (Addison [1711] 1854, 5:41) based on the authority of public opinion to which common sense lends philosophical justification (Habermas 1989, 93).

While philosophical legitimation and the political function of criticism pull Hume's theory of taste in opposite directions, the declared task of the "Standard of Taste" is to avert the consequences of subjective relativism: "It is natural for us to seek a *Standard of Taste*; a rule by which the various sentiments of men may be reconciled; at least a decision afforded confirming one sentiment, and condemning another" (Hume [1757] 1993, 136). Hume resolves the problem by shifting it from epistemology to methodology and placing at the centre of criticism the ideal critic (Levinson 2002; *contra* Ross 2008), moulded on Addison's "ideal spectator" (Pollock 2007). Equipped with a tuned sensorium, technical knowledge, and the correct socio-economic position (Hume [1757] 1993, 147), the ideal critic brings together sentimentalist theory and criticism's political function, applying criticism both to itself (as a subject of critical evaluation and metacritical inquiry) and to the socio-historical milieu

12 "Morals and criticism are not so properly objects of the understanding as of taste and sentiment. Beauty, whether moral or natural, is felt, more properly than perceived. Or if we reason concerning it, and endeavour to fix its standard, we regard a new fact, to wit, the general taste of mankind, or some such fact, which may be the object of reasoning and enquiry" (Hume [1748] 1975, 165).

that shaped it and the public taste that it shapes. If not interpreted literally as a physical person, but only as a situated arrangement of these heterogeneous elements, Hume's ideal critic is an "experimental system" which is criticism's "smallest integral working unit of research."

Rheinberger's dual concept of "epistemic thing" and "technical object" enables us to describe the structure of this situated experimental system. The task of the ideal critic is the aesthetic evaluation of objects. The process carried out in the experimental system begins from "that hardly definable something for the sake of which the whole experimental enterprise exists and around which it revolves" (Rheinberger 2011, 312). Rheinberger calls such objects "mandatorily underdetermined" (Rheinberger 2004, 4) "epistemic things"; and in Hume the expression "aesthetic things" may serve to designate natural or artificial objects conducive of beauty. Since "beauty is no quality in things themselves: it exists merely in the mind which contemplates them" (Hume [1757] 1993, 136), aesthetic things are not simply physical objects such as artworks that criticism accurately evaluates, but rather psycho-physically embodied and socio-historically embedded entities (Margolis 1974) that criticism contributes to construct. On the other hand, the equivalents of Rheinberger's "technical objects" that "bound and confine the assessment of the epistemic things" (Rheinberger 2004, 4) need not be limited to textual form but may also include material objects, such as artworks. These "cultural objects" form the specific "canon" (Levinson 2002; Mothersill 1989) with which experimental systems in criticism operate.

As the distinction between epistemic thing and technical object is for Rheinberger purely functional within the experimental system, so is for Hume the distinction between aesthetic thing and cultural object. More importantly, in relation to a posteriori paradigms in criticism, Hume does not philosophically distinguish criticism from art. Both are determined by the same sentiment of beauty and "rules of art," a probable association of sensorial impressions and sentiment discovered a posteriori "by genius *or* observation" (Hume [1757] 1993, 138, emphasis added).[13] Just as Rheinberger (1997, 138) dissolves the distinction between context of discovery and context of justification, so Hume dissolves the hierarchical relations between art and criticism, opening both up to new possibilities through hybridisation. This in turn resolves the relation between artwork and theory from within, making criticism not only a tacit dimension but an integral component of the production and presentation of the artwork (Borgdorff 2011, 53–54). Further, by changing the relation between artwork and theory, experimental criticism avoids the difficulties of institutional theories variously recurring in philosophy of art, such as George Dickie's "artworld systems" (Dickie 1984).

13 "Genius" does not confer on the artist any special cognitive status. Hume's loose use follows Dubos's *Réflexions critiques* and simply indicates a higher degree of understanding, delicacy, or cultivation. It is quite different from Kant's definition: "Genius ... is a talent for *producing* that for which no determinate rule can be given, not a predisposition of skill for that which can be learned in accordance with some rule" (Kant 2000, 186, typography regularised, emphasis added; see also 219).

DIFFERENTIAL REPRODUCTION

Having described the structure of Hume's smallest integral working unit of criticism, I will now examine the functionality of the ideal critic's constitutive elements: the aesthetic thing, grounded on sentiment of beauty, and the cultural object, grounded on aesthetic judgement.

Statements of criticism of the form "*X* is beautiful" appear to be about objects and have a truth-value. For Hume, on the contrary, statements of criticism are of the form "*X* is pleasing" and are nothing more than expressions of feelings with no truth-value. By redirecting his enquiry in the "Standard of Taste" from critical judgements to ideal critics, Hume can transform expressions of feelings into statements of the form "*C* says that *X* pleases him or her." The ideal critic's statements thus become aesthetic judgements that are socio-historical "matters of fact" and have truth-value (Hume [1748] 1975, 25).[14] The price for criticism becoming an empirical science is its conversion into metacriticism, a strategy adopted among others by Monroe Beardsley (1981, 1–4). While this analytic interpretation avoids more obvious contradictions (MacLachlan 1986, 18), it engenders a vicious circle between criteria for judging the critics and their critical judgements, as argued by Peter Kivy (1967).

This would be the case had Hume built a hierarchy of judgements (*contra* Levinson 2002) or separated criticism from other cognitive or social activities, but the complexity of the ideal critic and its openness to other systems prevents Kivy's vicious circle. The key lies in the relation of judgement and sentiment, a "reflective equilibrium," to use John Rawls's later expression (Rawls 1971, 20), but first described in "The New Riddle of Induction" by Nelson Goodman:

> This looks flagrantly circular. I have said that deductive inferences are justified by their conformity to valid general rules, and that general rules are justified by their conformity to valid inferences. But this circle is a virtuous one. The point is that rules and particular inferences alike are justified by being brought into agreement with each other. A rule is amended if it yields an inference we are unwilling to accept; an inference is rejected if it violates a rule we are unwilling to amend. The process of justification is the delicate one of making mutual adjustments between rules and accepted inferences; and in the agreement achieved lies the only justification needed for either. (Goodman [1954] 2002, 322)

In the same way, ideal critics negotiate "mutual adjustments" between judgements and sentiments by recursive comparisons to the point of agreement—subjectively between sentiment and judgement and intersubjectively between judgements.[15]

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14 "Matter of fact" is Hume's technical term for the probably true propositions of empirical science and history, as distinguished from the certain propositions of logic and from unjustified opinion. While this threefold distinction follows the *Port-Royal Logic* (1662), its strategic use in Hume should be brought in relation with Robert Boyle's experimentalism (Shapin and Schaffer 1985, 22) in the context of his general critique of Newton's apriorism (for an overview of Hume's Newtoniansm / anti-Newtonianism debate, see Schliesser [2008]). Boyle's "matter of fact" also clarifies the relation of Hume's aesthetic judgements and Rheinberger's "facta" (see next section).

15 One may say that Goodman is further elaborating on Hume's critique of induction in the *Treatise*: "It is evident, that when an object is attended with contrary effects, we judge of them only by our past experience, and always consider those as possible, which we have observed to follow from it. And as

"The caprices of mode and fashion" (Hume [1757] 1993, 139) present a specific challenge to reflective equilibrium in criticism. On one side, sentiment is non-rational and any idiosyncratic judgement is legitimate; on the other, fashion is a pervasive socio-historical phenomenon that can pervert sentiment[16] and that critics effectively reinforce because of the normative component present in every aesthetic judgement. It would follow that scientific reflective equilibrium would be indistinguishable from that established by social convention, so that the dialectic between aesthetic thing and cultural object is thrown into crisis. However, assuming human nature as relatively constant and cultural heritage as generally incremental, Hume can make the variability of aesthetic judgements mainly depend on varying socio-historical contexts and avert the risk of stasis by extending experimentation to universal history[17] and applying to it the "Rules by Which to Judge of Causes and Effects."[18] In a similar way for Rheinberger, the "fragmentation of science into systems" produces in each system a variety of "internal times" marked by "continuing cycles of nonidentical reproduction": the more "difference" (new findings) an experimental system produces, the further that system is from stasis and the more it is successful in its field (Rheinberger 1997, 68–69).

The characteristics of Hume's ideal critic guarantee that aesthetic judgement is grafted on sentiment while their plurality offers a control of its ideal

past experience regulates our judgment concerning the possibility of these effects, so it does that concerning their probability; and that effect, which has been the most common, we always esteem the most likely. Here then are two things to be considered, viz. the reasons which determine us to make the past a standard for the future, and the manner how we extract a single judgment from a contrariety of past events" (Hume [1739–40] 1961, 1:134). Conceptual differences notwithstanding, the standard of taste and the standard of induction both depend on Hume's law of causality and principles of cognition, and in both cases "standard" simply designates a regularity of pattern emerging from observation. Its respective function however, is somehow reversed: regarding judgements about matters of fact, it limits to probability inductive inferences about unobserved or future phenomena; regarding aesthetic judgements, it extends the application of induction, showing that the variety of sentiments is limited and does not imply arbitrariness.

16 For a perversion of natural sentiment, see for example, Hume's *Enquiry concerning the Principles of Morals* (Hume [1751] 1975, 270).

17 "Mankind are so much the same, in all times and places, that history informs us of nothing new or strange in this particular. Its chief use is only to discover the constant and universal principles of human nature, by showing men in all varieties of circumstances and situations, and furnishing us with materials from which we may form our observations and become acquainted with the regular springs of human action and behaviour. These records of wars, intrigues, factions, and revolutions, are so many collections of experiments, by which the politician or moral philosopher fixes the principles of his science, in the same manner as the physician or natural philosopher becomes acquainted with the nature of plants, minerals, and other external objects, by the experiments which he forms concerning them" (Hume [1748] 1975, 83–84).

18 In particular, rules 5 and 6: "(5) There is another principle, which hangs upon this [sc. "same cause always produces the same effect"], viz. that where several different objects produce the same effect, it must be by means of some quality, which we discover to be common amongst them. For as like effects imply like causes, we must always ascribe the causation to the circumstance, wherein we discover the resemblance. (6) The following principle is founded on the same reason. The difference in the effects of two resembling objects must proceed from that particular, in which they differ. For as like causes always produce like effects, when in any instance we find our expectation to be disappointed, we must conclude that this irregularity proceeds from some difference in the causes" (Hume [1739–40] 1961, 1:171). A long genealogy connects these rules backwards to the Aristotelian method of division in the Parts of Animals (Aristotle 1984b, 1:994–96) through Francis Bacon's "method of analysis by exclusion" (Sessions 1990, 141) and forwards, to John Stuart Mill's Method of Agreement and Difference (Mill [1843] 1974, "Of the Four Methods of Experimental Inquiry") and contemporary experimental biology (Weber 2005, 121; 2012).

status. Thus, the "true standard of taste and beauty" that consists in the "joint verdict" of the ideal critics (Hume [1757] 1993, 147) indicates synchronically the relation between embodied sentiment and embedded judgement and diachronically the relation between new aesthetic experiences and cultural tradition. When, on the other hand, aesthetic judgements disconnect from sentiment, the standard ceases to be a dynamic relation, becoming a socio-cultural norm for imitation. In the absence of new aesthetic experiences, ideal critics lose their function and the experimental system "dissipates" (Rheinberger 2008, 20:25). Thus, the description of the history of science as a museum of abandoned experimental systems may also apply to the history of criticism.

Before examining the sentiment of beauty as Hume's equivalent of the trace, an important difference should be noted concerning the "experimental conditions" of reproduction in the experimental system. Rheinberger finds them in the "transcendent immanence" of technology,[19] the laboratory equipment kept in a "hypo-critical" epistemic state and at the limit of its technical capacity (Rheinberger 2008). Hume relies instead on the uniformity and constancy of human nature: on one side, on the inner sense, ensuring *ceteris paribus* that the sentiment of beauty felt by each critic is commensurable; and, on the other, on sympathy, ensuring that sentiment is communicable through aesthetic judgement. Both Rheinberger and Hume construct their experimental systems as in Latour's hybrid "double separation," in which "Nature is transcendent but mobilizable (immanent)" and "Society is immanent but infinitely surpasses us (transcendent)" (Latour 1993, 41–43, 138–42); but mediation proceeds in opposite directions: Rheinberger technologises Nature, while Hume naturalises Society. Paradoxically, to some extent, these non-modern features (Aristotelian and humanistic)[20] profile the ideal critic as a paradigm candidate for criticism after modernity.

TRACE

Rheinberger's "material" constructivism (Rheinberger 2010, xiv–xv) and historical epistemology come the closest[21] to Hume's sceptical realism (Wright 1983; Read and Richman 2000) and naturalised epistemology (Quine 1969, 75) on the notion of trace. For both, the task of science is not theoretical explanation but empirical representation, where representation does not semantically refer to an external reality and experimental systems are not the medium of that representation. Rather, reality is constructed as a "second order concept" from intersecting representations of different experimental systems (Rheinberger

19 "Immanente Transzendenz" (Rheinberger 2008, 39:35). Here Rheinberger quotes with approval Edgar Wind's *Experiment and Metaphysics* (1934) but the oxymoronic expression "transcendent immanence" does not appear in that book. Unlike Kant, Wind does not draw a sharp distinction between "transcendent" and "transcendental" (Wind 2001, 48–49), and "transcendental immanence" may be more appropriate to Wind's "concrete systematic study of art" (konkrete Kunstwissenschaft) (Latella 2009). Particularly relevant to Rheinberger's experimental systems are Wind's "investigative instruments," summarised in Latella (2009, 9n53).

20 Cf. for instance the discussion on Hume's "fluid self" contrary to my interpretation in Seigel (2009, 45–50).

21 For a possible intersection, see van Fraassen (1980; 1989; 2008).

2000, 245). Thus, strictly speaking, there is no input; something, the data, originates outside and then enters the system, but only by means of its operative tracing.[22] Epistemic things are transformed into technical objects in a series of recursive "writings": first the inscription of traces, then the transcription of traces into facta (data) and finally the translation of facta into models (Lenoir 1998). Hume's formation of ideas[23] is equivalent to Rheinberger's recursive writing: "impressing" from perception (physical stimuli) to sensation becomes "copying" or "representing" (Hume [1739–40] 1961, 1:11) from sensation to idea, and "reflecting" from idea to sensation. At each stage, the causal determination of the "genuine index" (Peirce [1896–99] 1955, 108; see the "mark" in Hacking 1992, 44) progressively and irreversibly gives way to semantic complexity and expressiveness, so that reflexive impressions, such as the sentiment of beauty, are already less a product of simple impressions than of habit and belief. The last extension of that same writing, where individual aesthetic judgements are represented in public discourse, is the cultural object.

It is now possible to explain how Jacques Derrida's "arche-writing" especially connects Hume and Rheinberger. Hume constructs the aesthetic difference consistent with the relation between moral feeling and moral judgement.[24] The sentiment of approbation felt by the inner sense is *at the same time* the propositional content of moral and aesthetic judgements, and the entire natural-cultural hybrid of the ideal critic hinges on the instability of that association. In Derrida's terms, Hume's sentiment is a trace, the privileged term in the sentiment-judgement dichotomy that needs "erasing" (Derrida 1978, 403) and characterised by spacing and temporisation (Derrida 1982, 9). Sentiment is spaced in that it always refers to a system of differences, of aesthetic values that ensure the correct feeling is to be felt.[25] On the other hand, aesthetic judgements semantically depend on the sentiment they have

22 "They [sc. material signifying units] are usually termed data, but they should be rather addressed as facta in the sense of primary products of the research process. They acquire the horizon of their possible meaning within spaces of representation in which material traces and inscriptions—graphemes in a very general sense—become recorded, articulated, dislocated, reinforced, marginalized, and substituted" (Rheinberger 2004, 6).

23 "An impression first strikes upon the senses, and makes us perceive heat or cold, thirst or hunger, pleasure or pain of some kind or other. Of this impression there is a copy taken by the mind, which remains after the impression ceases; and this we call an idea. This idea of pleasure or pain, when it returns upon the soul, produces the new impressions of desire and aversion, hope and fear, which may properly be called impressions of reflexion, because derived from it. These again are copied by the memory and imagination, and become ideas; which perhaps in their turn give rise to other impressions and ideas. So that the impressions of reflexion are only antecedent to their correspondent ideas; but posterior to those of sensation, and derived from them" (Hume [1739–40] 1961, 1:17).

24 "To have the sense of virtue, is nothing but to feel a satisfaction of a particular kind from the contemplation of a character. The very *feeling* constitutes our praise or admiration. We go no farther; nor do we enquire into the cause of the satisfaction. We do not infer a character to be virtuous, because it pleases: But in feeling that it pleases after such a particular manner, we in effect feel that it is virtuous. The case is the same as in our judgments concerning all kinds of beauty, and tastes, and sensations. Our approbation is implied in the immediate pleasure they convey to us" (Hume [1739–40] 1961, 2:179).

25 "Some species of beauty, especially the natural kinds, on their first appearance, command our affection and approbation; and where they fail of this effect, it is impossible for any reasoning to redress their influence, or adapt them better to our taste and sentiment. But in many orders of beauty, particularly those of the finer arts, it is requisite to employ much reasoning, in order to feel the proper sentiment; and a false relish may frequently be corrected by argument and reflection. There are just grounds to conclude, that moral beauty partakes much of this latter species, and demands the assistance of our intellectual faculties, in order to give it a suitable influence on the human mind" (Hume [1751] 1975, 173).

already displaced, and therefore sentiment is also temporised, indefinitely deferred to the convergence of judgements on a standard of taste.

Hume relies here on the embodiedness of sentiment and the embeddedness of judgement, but how do sentiment and judgement form a system in the first place and how does writing sustain that system over time? Gilles Deleuze clearly recognises the problem. Reversing the Kantian question, *Empiricism and Subjectivity* asks how the subject (human nature) is constituted within the given (Deleuze 1991, 22). In Hume-Deleuze there is no "pre-existing subject" and "empirical subjectivity is constituted in the mind under the influence of the principles affecting it" (ibid., 29). These principles form a "network of tendencies" (ibid., 25) that transforms by habit and belief the multiplicity of ideas into "what we call our Self" (Hume [1739–40] 1961, 1:238). This bundle theory of the self is a system in which natural, psychological, and social principles are identical (Deleuze 1991, 111–12) and entirely immanent, so that "nothing is ever transcendental" (ibid., 24), including the fiction of the subject. In a celebrated passage, Hume compares the mind to "a kind of theatre, where several perceptions successively make their appearance; pass, re-pass, glide away, and mingle in an infinite variety of postures and situations" (Hume [1739–40] 1961, 1:239–40).

When he describes experimental systems as "spaces of representation," Rheinberger (1995, 114–15) too uses a theatrical analogy. Introducing the trace, he distinguishes three meanings that the German word for "representation" (*Darstellung*) synthesises: substitution (*Stellvertretung*), embodiment (*Verkörperung*), and realisation (*Realisierung*). Theatre actors are both the substitution of other actors performing the same role and the embodiment of a fictional character in a play (Rheinberger 2000, 235–36). Further, in this differential reproduction the actor's enactment constitutes his or her fictional character as a quasi-subject, at least partially autonomous from the fictional character and from the actor. Rheinberger's meanings of representation are also present in Hume, where substitution is realised by the copy principle at the level of impressions, and embodiment at the level of particular configurations of ideas by the "principles of union or cohesion" (Hume [1739–40] 1961, 1:21): resemblance, contiguity, and cause and effect. Finally, but without solution of continuity, the operations of association do not just put ideas together but also change their intensity ("liveliness"),[26] so that impressions and sentiments are "erased" while new properties emerge ("beliefs").[27] As for Rheinberger, so for

26 "The distinct boundaries and offices of *reason* and of *taste* are easily ascertained. The former conveys the knowledge of truth and falsehood: the latter gives the sentiment of beauty and deformity, vice and virtue. The one discovers objects as they really stand in nature, without addition and diminution: the other has a productive faculty, and gilding or staining all natural objects with the colours, borrowed from internal sentiment, raises in a manner a new creation" (Hume [1751] 1975, 294).

27 "The first time a man saw the communication of motion by impulse, as by the shock of two billiard balls, he could not pronounce that the one event was connected: but only that it was conjoined with the other. After he has observed several instances of this nature, he then pronounces them to be connected. What alteration has happened to give rise to this new idea of connexion? Nothing but that he now feels these events to be connected in his imagination, and can readily foretell the existence of one from the appearance of the other. When we say, therefore, that one object is connected with another, we mean only that they have acquired a connexion in our thought, and give rise to this inference, by which they become proofs of each other's existence: A conclusion which is somewhat extraordinary, but which seems founded on sufficient evidence" (Hume [1748] 1975, 75–76, italics removed).

Hume; reality is not what is left after purifying representations from experimental conditions, but what is produced by the socio-historical process of experimentation within and across experimental systems.

EXPERIMENTAL CULTURE

The last characteristic to be examined is how experimental systems form together "ensembles." Rheinberger calls them "experimental cultures" and uses them to study the formation of scientific fields and disciplines.[28] Although he expresses caution about extending concepts from evolutionary biology, experimental systems show strong similarities to heredity in biological species, notably in the vertical transmission within experimental systems and in the horizontal transmission within cultures of experimentation, in which the technical object acts as replicator.[29]

In support of his constructive empiricism, van Fraassen had already reversed the argument that "realism is the only philosophy that does not make the success of science a miracle" (Putnam 1975, 73), arguing that scientific theories are not successful because they are true but, instead, are empirically adequate because they have organically evolved in a process of scientific selection (van Fraassen 1980, 40). But Rheinberger goes further by constructing a historical-epistemic model of scientific research that reduces scientific communities to collectives (Latour 1993, 4) and excludes other contributing factors to scientific selection and epistemic success. Experimental systems are an epistemic "*machine* for making the *future*" (Rheinberger 1998, 288, emphasis added), but they also organise the social, economical, and institutional conditions of that production. They depend for this on other spheres of communication and interaction and compete against one another on both epistemic and social grounds, by means of which they succeed or fail in the process of scientific selection.[30] Therefore, it appears that Rheinberger's material constructivism, coupled with strong relativism, also requires experimental systems to be autonomous.[31] This raises a number of questions concerning the relation between

28 "Conjunctures and ramifications of experimental systems can lead to ensembles of such systems, or experimental cultures. Conjunctures and ramifications themselves are, as a rule, the result of unprecedented events within experimental systems, events that are often connected to the introduction of new technologies of representation. In the last instance, it is such experimental cultures that determine the contours of scientific disciplines, their emergence as well as their historical obsolescence. The concept of experimental culture as an articulated ensemble of experimental systems should allow to write histories of research fields without the burden of a disciplinary history. But this is not only a historiographical issue. The more basic argument is that experimental science does derive its dynamics less from the shaping of disciplinary boundaries and their social solidification than from the digressions and transgressions of smaller units below the level of disciplines in which knowledge is not yet labelled and classified, and in which new knowledge forms can take shape" (Rheinberger 2004, 6).

29 For an overview of cultural evolutionism, see Wheeler, Ziman, and Boden (2002). Sporadic examples of evolutionary interpretation of deconstruction are Spolsky (2002); Milburn (2003); Smith (2012).

30 See Hempel ([1978] 2001, 370). Epistemic success is the system's "capacity to produce differences that count as unprecedented events and keep the machinery going" (Rheinberger 1997, 180). On the self-referentiality of experimental systems, see Bloor (2005, 309). For a further development of experimental cultures in sociology of knowledge, see "epistemic cultures" in Knorr Cetina (1999, 8).

31 Richard Burian (1995; 1997) convincingly reframes the trace as the production of variation in the evolution of complex systems. The questions then are whether experimental systems have the critical degree of complexity that allows autonomy and, conversely, whether enough synchronic variety and diachronic

Rheinberger's experimental systems and experimental cultures or society at large. For instance, if experimental systems only perform operations that maximise epistemic gain, then they are regulated by a dialectics of means (technical object) to ends (epistemic thing) and their autonomy would merely be negative. In this way, however, moral judgements about the outcomes of experimental systems can only be formulated in society as external limitations of their autonomy and hence of their epistemic function. Although the opposition of positive and negative autonomy in experimental systems[32] exceeds our present subject matter, those questions become all the more pressing in criticism, where the sociological component more significantly affects its experimental systems, the critics.

Strong relativism is also a requirement for ideal critics; but whereas the technoscientific component determines the evolution of Rheinberger's experimental systems as well as the quality and increase of knowledge they produce, for Hume criticism is driven by a form of immanent ethics.[33] Only if critics are fully integrated in society can they perform their socio-historical function. This is not to say that Hume shares the optimism of his friends Turgot and Condorcet, as he rejects both historical teleology[34] and determinism.[35] Progress, stasis, or regress describe instead trajectories of socio-historical systems, such as taste, in which all individuals are immersed. In "Of the Rise and Progress of the Arts and Sciences," Hume argues that science and art flourish last, after social, political, and economical conditions are ripe, and wither first when they change, but only passions ultimately determine individual and hence collective behaviours (Hume [1742b] 1993, 67).[36]

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discontinuity is found in the history of science. For cultural evolutionism in epistemology, see Hull (1988). On discontinuity in Bachelard's philosophy of science compare Rheinberger (2005) and Young (2004, 84–89).

32 Isaiah Berlin distinguishes negative freedom (which addresses the question "What is the area within which the subject—a person or group of persons—is or should be left to do or be what he is able to do or be, without interference by other persons?") from positive freedom (which addresses the question "What, or who, is the source of control or interference that can determine someone to do, or be, this rather than that?" (Berlin 1969, 121–2). The de facto opposition he traces can be easily extended to autonomy.

33 For the dependence of virtue on passion, see Hume ([1751] 1975, 277); Russell (2006). In the *Treatise*, philosophy in the literal sense of "love of knowledge" is assimilated to theoretical curiosity and compared to hunting: "I shall observe, that there cannot be two passions more nearly resembling each other, than those of hunting and philosophy, whatever disproportion may at first sight appear betwixt them" (Hume [1739–40] 1961, 2:159) and gaming "we may consider the passion of gaming, which affords a pleasure from the same principles as hunting and philosophy" (Hume [1739–40] 1961, 2:160). For "theoretical curiosity," see Zuss (2012); for curiosity and the birth of modern science, see Blumenberg (1985). For the notion of "immanent ethics" in Deleuze, here extended to Hume-Deleuze, see Jun (2011, 95).

34 See part two of Hume's *Dialogues concerning Natural Religion* (Hume [1779] 1991, 97–113); for its likely antecedent, see Voltaire's "S'il y a un Dieu" (Whether there is a God), the second chapter of the *Treatise on Metaphysics* (written 1734–37) (Voltaire 1784, 19–33); for the seventeenth-century "intelligent design" debate, see Roger (1997, 331–33); for the modern "intelligent design" debate, see Dawkins ([1986] 1996).

35 See Badía Cabrera (2001, 117). For example, Hume discusses classical revolutions and the possibility of universal decay in "Of the Populousness of Ancient Nations" ([1742a] 1993).

36 For evolutionism in Hume see Dennett (1995, 28–34); for his influence on Darwin, see Huntley (1972); for his influence on Lamarck, see Sloan (1999); for Lamarckism in cultural evolution, see Kronfeldner (2007); *contra* Mesoudi (2011); in support of both Darwinism and Lamarckism in cultural evolution, see Hodgson and Knudsen (2006; 2010).

In particular, Hume identifies the passion causing the critic to ascertain true aesthetic sentiment with theoretical curiosity. Curiosity is both an epistemic virtue connecting subjective learning to moral sentiment and a social virtue connecting intersubjective understanding to moral sentiment via sympathy (Hume [1739–40] 1961, 2:77–78).[37] Here "It is natural for us to seek a Standard of Taste" clearly resonates with Aristotle's "All men by nature desire to know" (Aristotle 1984a, 2:1552).

In Kant, a tension line divides sense from sensibility, and their harmony is the a priori condition for the "subjectively universal validity" of aesthetic judgement (Kant 2000, 100). In contrast, Hume's Pleasure Principle creates an intensity gradient between one critic's truthfulness to sentiment and her or his agreement with other critics (cf. Deleuze 1991, 44), thus giving to aesthetic judgement an indefinite range of possibilities. But although all aesthetic judgements are valid as expression of a sentiment, not all of them are correct. The "Polite and judicious conversation" in "Of the Delicacy of Taste and Passion" (Hume [1741–2] 1993, 10) represents neither a moral ideal of the critic nor a rhetorical apparatus for social validation but rather the "experimental culture" producing the standard of taste. As (metastable) reflective equilibrium, one standard of taste or another can always be identified in any experimental culture; but at the same time, the changing of standards shows a characteristic tendency of that experimental culture.[38] The virtue of curiosity operates in the gap between prevailing aesthetic judgements and the limit of sentiment, ensuring the critic's continuing "production of difference."[39] As Michel Foucault describes it:

> Curiosity is a vice that has been stigmatized in turn by Christianity, by philosophy, and even by a certain conception of science. Curiosity, futility. The word, however, pleases me. To me it suggests something altogether different: it evokes "concern"; it evokes the care one takes for what exists or could exist; a readiness to find strange and singular what surrounds us; a certain relentlessness to break up our familiarities and to regard otherwise the same things; a fervor to grasp what is happening and what passes; a casualness in regard to the traditional hierarchies. I dream of a new age of curiosity. (Foucault [1997] 2000, 325)

That age may not be entirely new, as my cross-reading of Rheinberger's epistemology of experimental systems with Hume's science of criticism has tried to show; nor does the 2002 crisis of criticism necessarily mark its beginning.

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37 Setting aside technicalities and limitations of virtue epistemology (for a recent overview, see Brady and Pritchard [2003]), epistemic virtues can be broadly defined as "qualities or character traits thought to be truth-conducive" (Montmarquet 1987, 482). Virtue epistemology is consistent with the Hume-Deleuzian subject outlined before; see Cohen (2000, 115).

38 In the literature, the relation of Hume and Mathematics is mostly ignored. However, discussing differentials in the *Encyclopédie* entry on "limit," d'Alembert already says that: "One magnitude is said to be the limit of another magnitude when the second may approach the first within any given magnitude however small, although the first magnitude may never exceed the magnitude it approaches" (quoted in Suisky 2009, 140n101, italics removed). For an ethical interpretation of Kant's ideal, see Hauskeller (2003).

39 For "creative difference" in contrast to Derrida's "analytic difference," see Deleuze (1994, 37–51), further elaborated as "desiring-production" in Deleuze and Guattari (1984).

Nevertheless experimental systems in general, and criticism in particular, remain dependant on the society in which they are embedded; and curiosity, or critique, as Foucault also refers to this virtue,[40] still affords to criticism its only antidote against conformism and irrelevance.

40 "Critique only exists in relation to something other than itself: it is an instrument, a means for a future or a truth that it will not know nor happen to be, it oversees a domain it would want to police and is unable to regulate. . . . [Critique] brings not only some stiff bit of utility it claims to have, but also that it is supported by some kind of more general imperative—more general still than that of eradicating errors. There is something in critique which is akin to virtue" (Foucault 2007, 42–43). The criticism/critique distinction remains unclear in Butler (2002) or is reduced to historical periodisation in Rogoff (2006). For the impossibility of the task, see Benjamin (1996, 259); De Man (1983, 80). For Derrida's aporetic ethics, see Zlomislić (2007).

REFERENCES

Addison, Joseph. (1711) 1854. "The Uses of the Spectator." In *The Works of Joseph Addison*, edited by George Washington Greene, 6 vols., 5:41–5. New York: Putnam. First published in *The Spectator* 10, 12 March 1711.

———. (1712) 1854. "Characteristics of Taste." In *The Works of Joseph Addison*, edited by George Washington Greene, 6 vols., 6:315–21. New York: Putnam. First published in *The Spectator* 409, 19 June 1712.

Anstey, Peter, and Alberto Vanzo. 2012. "The Origins of Early Modern Experimental Philosophy." *Intellectual History Review* 22 (4): 499–518.

Aristotle. 1984a. *Metaphysics*. Translated by W. D. Ross. In: *The Complete Works of Aristotle*, edited by Jonathan Barnes, 2 vols., 2:1552–728. Princeton, NJ: Princeton University Press / Bollingen Series.

———. 1984b. *Parts of Animals*. Translated by William Ogle. In *The Complete Works of Aristotle*, edited by Jonathan Barnes, 2 vols., 1:994–1086. Princeton, NJ: Princeton University Press / Bollingen Series.

Bachelard, Gaston. 1984. *The New Scientific Spirit*. Translated by Arthur Goldhammer. Boston: Beacon Press. First published 1934 as *Le nouvel esprit scientifique* (Paris: Alcan).

Badía Cabrera, Miguel A. 2001. *Hume's Reflection on Religion*. International Archives of the History of Ideas 178. Dordrecht: Kluwer.

Baker, George, Rosalind Krauss, Benjamin Buchloh, Andrea Fraser, David Joselit, James Meyer, Robert Storr, Hal Foster, John Miller, and Helen Molesworth. 2002. "Round Table: The Present Conditions of Art Criticism." *October* 100 (Spring): 200–28.

Beardsley, Monroe C. 1981. Aesthetics: Problems in the Philosophy of Criticism. 2nd ed. Indianapolis, IN: Hackett.

Belting, Hans. 2003. *Art History after Modernism*. Chicago: University of Chicago Press.

Benjamin, Walter. 1996. "The Task of the Translator." Translated by Harry Zohn. In *Walter Benjamin: Selected Writings, Vol. 1, 1913–1926*, edited by Marcus Bullock and Michael W. Jennings, 253–63. Cambridge, MA: Belknap Press of Harvard University Press. Essay first published 1923 as "Die Aufgabe des Übersetzers." This translation first published 1968.

Berger, Maurice, ed. 1998. The Crisis of Criticism. New York: New Press.

Berlin, Isaiah. 1969. "Two Concepts of Liberty." In Four Essays on Liberty, 118–72. Oxford: Oxford University Press.

Bloor, David. 2005. "Toward a Sociology of Epistemic Things." *Perspectives on Science* 13 (3): 285–312.

Blumenberg, Hans. 1985. *The Legitimacy of the Modern Age*. Translated by Robert M. Wallace. Cambridge, MA: MIT Press. First published 1966 as *Die Legitimität der Neuzeit* (Frankfurt am Main: Suhrkamp).

Borgdorff, Henk. 2011. "The Production of Knowledge in Artistic Research." In The Routledge Companion to Research in the Arts, edited by Michael Biggs and Henrik Karlsson, 44–63. Abingdon, UK: Routledge.

Bourdieu, Pierre. 1984. Distinction: A Social Critique of the Judgement of Taste. Translated by Richard Nice. Cambridge, MA: Harvard University Press. First published 1979 as *La distinction: Critique sociale du jugement* (Paris: Éditions de Minuit).

Brady, Michael, and Duncan Pritchard, eds. 2003. *Moral and Epistemic Virtues*. Oxford: Blackwell.

Burian, Richard M. 1995. "Comments on Hans-Jörg Rheinberger's 'From Experimental Systems to Cultures of Experimentation.'" In *Concepts, Theories, and Rationality in the Biological Sciences: The Second Pittsburgh-Konstanz Colloquium in the Philosophy of Science, University of Pittsburgh, October 1–4, 1993*, edited by Gereon Wolters and James G. Lennox with Peter McLaughlin, 123–36. Pittsburgh, PA: University of Pittsburgh Press.

———. 1997. "Comments on Complexity and Experimentation in Biology." In "Proceedings of the 1996 Biennial Meetings of the Philosophy of Science Association; Part 2: Symposia Papers," supplement, *Philosophy of Science* 64: S279–91.

Butler, Judith. 2002. "What is Critique? An Essay on Foucault's Virtue." In *The Political*, edited by David Ingram, 212–28.

Blackwell Readings in Continental Philosophy. Oxford: Blackwell.
Chatterjee, Anjan. 2011. "Neuroaesthetics: A Coming of Age Story." *Journal of Cognitive Neuroscience* 23 (1): 53–62.
Cohen, Alix. 2000. "The Notion of Moral Progress in Hume's Philosophy: Does Hume Have a Theory of Moral Progress?" Hume Studies 26 (1): 109–27.
Cunningham, Andrew S. 2004. "The Strength of Hume's 'Weak' Sympathy." *Hume Studies* 30 (2): 237–56.
Davis, Whitney. 2011. *A General Theory of Visual Culture*. Princeton, NJ: Princeton University Press.
Dawkins, Richard. (1986) 1996. *The Blind Watchmaker*. New York: Norton.
De la Fuente, Eduardo. 2007. "The 'New Sociology of Art': Putting Art Back into Social Science Approaches to the Arts." *Cultural Sociology* 1 (3): 409–25.
Deleuze, Gilles. 1991. *Empiricism and Subjectivity: An Essay on Hume's Theory of Human Nature*. Translated by Constantin V. Boundas. New York: Columbia University Press. First published 1953 as *Empirisme et subjectivité: Essai sur la Nature Humaine selon Hume* (Paris: Presses Universitaires de France).
———. 1994. *Difference and Repetition*. Translated by Paul Patton. London: Athlone Press. First published 1968 in French as *Différence et répétition* (Paris: Presses Universitaires de France).
Deleuze, Gilles, and Félix Guattari. 1984. *Anti-Oedipus: Capitalism and Schizophrenia*. Translated by Robert Hurley, Mark Seem, and Helen R. Lane. London: Athlone Press. First published 1972 in French as *L'anti-Œdipe* (Paris: Éditions de Minuit).
De Man, Paul. 1967. "The Crisis of Contemporary Criticism." *Arion* 6 (1): 38–57. Revised version published as "Criticism and Crisis" in De Man 1971, 3–19.
———. 1971. *Blindness and Insight: Essays in the Rhetoric of Contemporary Criticism*. New York: Oxford University Press.
———. 1983. "'Conclusions': Walter Benjamin's 'Task of the Translator.'" In *The Resistance to Theory*, 1986, 73–105. Minneapolis: Minnesota University Press.
Dennett, Daniel C. 1995. *Darwin's Dangerous Idea: Evolution and the Meanings of Life*. New York: Touchstone.
Derrida, Jacques. 1978. *Writing and Difference*. Translated by Alan Bass. London: Routledge & Kegan Paul. First published 1967 as *L'écriture et la différence* (Paris: Éditions du Seuil).
———. 1982. "Différance." In *Margins of Philosophy*, translated by Alan Bass, 1–28. Chicago: University of Chicago Press. First published 1972 as *Marges de la philosophie* (Paris: Éditions de Minuit).
Descartes, René. 1985. *Principles of Philosophy*. In vol. 1 of *The Philosophical Writings of Descartes*, translated by John Cottingham, Robert Stoothoff, and Dugald Murdoch, 177–292. Cambridge: Cambridge University Press. First published 1644 as *Principia Philosophiae*.
Dickie, George. 1984. *The Art Circle: A Theory of Art*. New York: Haven.
———. 1996. *The Century of Taste: The Philosophical Odyssey of Taste in the Eighteenth Century*. New York: Oxford University Press.
Dubos, Jean-Baptiste. (1719) 1993. *Réflexions critiques sur la poésie et sur la peinture*. Edited by Dominique Désirat. Paris: École nationale supérieure des Beaux-Arts.
Dutton, Denis. 2009. *The Art Instinct: Beauty, Pleasure, and Human Evolution*. Oxford: Oxford University Press.
Eagleton, Terry. 1984. *The Function of Criticism: From the Spectator to Post-Structuralism*. London: Verso.
Elkins, James. 2003. *Visual Studies: A Skeptical Introduction*. London: Routledge.
———. ed. 2008. *Visual Literacy*. London: Routledge.
———. 2010. "Remarks on the State of Art Criticism." Paper presented at the AICA UK Annual Inaugural Lecture in association with Tate, Tate Modern, London, 13 December.
Förster, Eckart, ed. 1989. *Kant's Transcendental Deductions: The Three Critiques and Opus postumum*. Stanford, CA: Stanford University Press.
Foucault, Michel. (1997) 2000. "What is Enlightenment?" In *Ethics: Subjectivity and Truth; The Essential Works of Foucault, 1954–1984, Vol. 1*, edited by Paul Rabinow, translated by Robert Hurley et al., 303–20. London: Penguin. First published in English 1984 in *The Foucault Reader*, edited by Paul Rabinow (New York: Pantheon). This edition first published 1997 (New York: New Press).
———. 2007. "What is Critique?" In *The Politics of Truth*, edited by Sylvère Lotringer,

translated by Lysa Hochroth and Catherine Porter, 41–81. Los Angeles: Semiotext(e). Originally delivered as a lecture in 1978; first published 1990 as "Qu'est-ce que la critique?" (*Bulletin de la Société française de la philosophie* 84 [2]: 35–63).

Frank, Gustav, and Barbara Lange. 2010. *Einführung in die Bildwissenschaft: Bilder in der visuellen Kultur*. Darmstadt: WBG.

Frey, Bruno S. 2003. *Arts and Economics: Analysis and Cultural Policy*. 2nd ed. Berlin: Springer.

Gadamer, Hans-Georg. (1989) 2004. *Truth and Method*. 2nd ed. Translated by W. Glen-Doepel, translation revised by Joel Weinsheimer and Donald G. Marshall. London: Continuum. First published 1960 as *Wahrheit und Methode: Grundzüge einer philosophischen Hermeneutik* (Tübingen: Mohr). This translation first published 1975 (London: Sheed and Ward); 2nd edition first published 1989 (London: Sheed and Ward).

Goodman, Nelson. (1954) 2002. "The New Riddle of Induction." In *Epistemology: Contemporary Readings*, edited by Michael Huemer, 320–32. London: Routledge.

Gottschall, Jonathan. 2012. *The Storytelling Animal: How Stories Make Us Human*. Boston: Houghton Mifflin Harcourt.

Groys, Boris. 2008. *Art Power*. Cambridge, MA: MIT Press.

Habermas, Jürgen. 1989. *The Structural Transformation of the Public Sphere: An Inquiry into a Category of Bourgeois Society*. Translated by Thomas Burger with Frederick Lawrence. Cambridge, MA: MIT Press. First published 1962 as *Strukturwandel der Öffentlichkeit: Untersuchungen zu einer Kategorie der bürgerlichen Gesellschaft* (Neuwied: Luchterhand).

Hacking, Ian. 1992. "The Self-Vindication of the Laboratory Sciences." In *Science as Practice and Culture*, edited by Andrew Pickering, 29–64. Chicago: University of Chicago Press.

Harvey, William. 1970. *Exercitatio anatomica de motu cordis et sanguinis in animalibus: An English Translation*. Translated by Chauncey D. Leake. 5th ed. Springfield, IL: Thomas. First published 1628; this translation first published 1928.

Hauskeller, Christine. 2003. "Natur als Grenzbegriff kultureller Machbarkeit." In *Natur als Politikum*, edited by Margarete Maurer and Otmar Höll, 175–94. Vienna: RLI-Verlag.

Hazony, Yoram. 2009. "Hume's 'System of the Sciences' as a Challenge to Newtonian Science." Filmed at "The Human Nature Tradition in Anglo Scottish Philosophy: Its History and Future Prospects," The Shalem Center, Jerusalem, 14–17 December. Vimeo video, 1:02:01. Accessed 15 May 2013. http://vimeo.com/18705047.

Hempel, Carl G. (1978) 2001. "Scientific Rationality: Normative versus Descriptive Construals." In *The Philosophy of Carl G. Hempel: Studies in Science, Explanation, and Rationality*, edited by James H. Fetzer, 357–71. New York: Oxford University Press.

Hodgson, Geoffrey M., and Thorbjørn Knudsen. 2006. "Dismantling Lamarckism: Why Descriptions of Socio-Economic Evolution as Lamarckian are Misleading." *Journal of Evolutionary Economics* 16 (4): 343–66.

———. 2010. *Darwin's Conjecture: The Search for General Principles of Social and Economic Evolution*. Chicago: University of Chicago Press.

Horowitz, Noah. 2011. *Art of the Deal: Contemporary Art in a Global Financial Market*. Princeton, NJ: Princeton University Press.

Hull, David L. 1988. *Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science*. Chicago: University of Chicago Press.

Hume, David. (1739–40) 1961. *A Treatise of Human Nature*. 2 vols. London: Dent. Dent edition first published 1911.

———. (1741–2) 1993. "Of the Delicacy of Taste and Passion." In Hume 1993, 10–13.

———. (1742a) 1993. "Of the Populousness of Ancient Nations." In Hume 1993, 223–74.

———. (1742b) 1993. "Of the Rise and Progress of the Arts and Sciences." In Hume 1993, 56–77.

———. (1748) 1975. *An Enquiry concerning Human Understanding*. In Hume (1777) 1975, 5–168.

———. (1751) 1975. *An Enquiry concerning the Principles of Morals*. In Hume (1777) 1975, 169–323.

———. (1752) 1993. "Of Refinement in the Arts." In Hume 1993, 167–77.

———. (1757) 1993. "Of the Standard of Taste." In Hume 1993, 133–54.
———. (1766) 1932. Letter from David Hume to Adam Smith, August. In *The Letters of David Hume*, edited by J. Y. T. Greig, 2 vols., 2:82–3. Oxford: Oxford University Press / Clarendon Press.
———. (1769) 1932. Letter from David Hume to Abbé Morellet, 10 July. In *The Letters of David Hume*, edited by J. Y. T. Greig, 2 vols., 2:203–6. Oxford: Oxford University Press / Clarendon Press.
———. (1777) 1975. *Enquiries concerning Human Understanding and concerning the Principles of Morals*. Edited by L. A. Selby-Bigge. 3rd ed. Revised by P. H. Nidditch. Oxford: Oxford University Press / Clarendon Press. *An Enquiry concerning Human Understanding* first published 1748; *An Enquiry concerning the Principles of Morals* first published 1751. Clarendon Press edition first published 1894, reprinted from an edition of 1777.
———. (1779) 1991. *Dialogues concerning Natural Religion*. In *Dialogues concerning Natural Religion in Focus*, edited by Stanley Tweyman, 95–185. Abingdon, UK: Routledge.
———. 1993. *Selected Essays*. Edited by Stephen Copley and Andrew Edgar. Oxford: Oxford University Press.
Huntley, William B. 1972. "David Hume and Charles Darwin." In "Festschrift for Philip P. Wiener," special issue, *Journal of the History of Ideas* 33 (3): 457–70.
Hutcheson, Francis. (1725) 2008. *An Inquiry into the Original of Our Ideas of Beauty and Virtue: In Two Treatises*. Edited by Wolfgang Leidhold. Rev. ed. Indianapolis, IN: Liberty Fund.
Huxley, Thomas H. 1879. *English Men of Letters: Hume*. London: Macmillan.
Israel, Jonathan I. 2001. *Radical Enlightenment: Philosophy and the Making of Modernity, 1650–1750*. Oxford: Oxford University Press.
Jun, Nathan. 2011. "Deleuze, Values, and Normativity." In *Deleuze and Ethics*, edited by Nathan Jun and Daniel W. Smith, 89–107. Edinburgh: Edinburgh University Press.
Kant, Immanuel. 2000. *Critique of the Power of Judgment*. Edited by Paul Guyer, translated by Paul Guyer and Eric Matthews. Cambridge: Cambridge University Press. First published 1790 as *Kritik der Urteilskraft*.
———. 2004. *Prolegomena to Any Future Metaphysics That Will Be Able to Come Forward As Science; With Selections from the Critique of Pure Reason*. Translated and edited by Gary Hatfield. Rev. ed. Cambridge: Cambridge University Press. First published 1783 as *Prolegomena zu einer jeden künftigen Metaphysik, die als Wissenschaft wird auftreten können*.
Kaplan, Abraham. 1948. "On the So-Called Crisis in Criticism." *Journal of Aesthetics and Art Criticism* 7 (1): 42–48.
Kivy, Peter. 1967. "Hume's Standard of Taste: Breaking the Circle." *British Journal of Aesthetics* 7 (1): 57–66.
Knorr Cetina, Karin. 1999. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, MA: Harvard University Press.
Knox-Shaw, Peter. 2008. "Hume's 'Farther Scenes': Maupertuis and Buffon in the *Dialogues*." *Hume Studies* 34 (2): 209–30.
Krauss, Rosalind E. 1985. *The Originality of the Avant-Garde and Other Modernist Myths*. Cambridge, MA: MIT Press.
Kronfeldner, Maria E. 2007. "Is Cultural Evolution Lamarckian?" *Biology and Philosophy* 22 (4): 493–512.
Latella, Consolato. 2009. "Wind and Reigl: The Meaning of a 'Problematical' Grammar." *Journal of Art Historiography* 1. Accessed 12 December 2012. http://arthistoriography.files.wordpress.com/2011/02/media_139156_en.pdf.
Latour, Bruno. 1993. *We Have Never Been Modern*. Translated by Catherine Porter. Cambridge, MA: Harvard University Press. First published 1991 as *Nous n'avons jamais été modernes: Essai d'anthropologie symétrique* (Paris: La Découverte).
Latour, Bruno, and Peter Weibel, eds. 2002. *Iconoclash: Beyond the Image Wars in Science, Religion, and Art*. Cambridge, MA: MIT Press.
Lenoir, Timothy, ed. 1998. *Inscribing Science: Scientific Texts and the Materiality of Communication*. Stanford, CA: Stanford University Press.
Levinson, Jerrold. 2002. "Hume's Standard of Taste: The Real Problem." *Journal of Aesthetics and Art Criticism* 60 (3): 227–38.
Mace, Dean. 1997. "Literature and the Other Arts: Parallels Between the Arts." In *The Cambridge History of Literary Criticism; Vol. 4: The Eighteenth Century*, edited by H. B. Nisbet and Claude Rawson, 730–41. Cambridge: Cambridge University Press.

MacLachlan, Christopher. 1986. "Hume and the Standard of Taste." *Hume Studies* 12 (1): 18–38.

Malherbe, Michel. 2005. "Hume's Reception in France." In *The Reception of David Hume in Europe*, edited by Peter Jones, 43–97. London: Thoemmes Continuum.

Manovich, Lev. 2012. "How and Why Study Big Cultural Data," 2nd version. Software Studies Initiative PowerPoint presentation. Accessed 14 May 2013. http://lab.softwarestudies.com/2008/09/cultural-analytics.html.

Margolis, Joseph. 1974. "Works of Art as Physically Embodied and Culturally Emergent Entities." *British Journal of Aesthetics* 14 (3): 187–96.

Mayo, Deborah G. 1994. "The New Experimentalism, Topical Hypotheses, and Learning from Error." In *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association; Vol. 1, Symposia and Invited Papers*, edited by Richard M. Burian, Micky Forbes, and David Hull, 270–79. East Lansing, MI: Philosophy of Science Association.

Mesoudi, Alex. 2011. *Cultural Evolution: How Darwinian Evolutionary Theory Can Explain Human Culture and Synthesize the Social Sciences.* Chicago: University of Chicago Press.

Milburn, Colin Nazhone. 2003. "Monsters in Eden: Darwin and Derrida." *MLN* 118 (3): 603–21.

Mill, John Stuart. (1843) 1974. *A System of Logic Ratiocinative and Inductive, Being a Connected View of the Principles of Evidence and the Methods of Scientific Investigation (Books I–III)*. Vol. 7 of *The Collected Works of John Stuart Mill*, edited by John M. Robson. Toronto: University of Toronto Press; London: Routledge and Kegan Paul.

Montmarquet, James A. 1987. "Epistemic Virtue." *Mind* 96 (384): 482–97.

Moretti, Franco. 2005. *Graphs, Maps, Trees: Abstract Models for a Literary History*. London: Verso.

Morris, Wesley. 1972. *Toward a New Historicism*. Princeton, NJ: Princeton University Press.

Mossner, Ernest Campbell. 1980. *The Life of David Hume*. 2nd ed. Oxford: Oxford University Press / Clarendon Press.

Mothersill, Mary. 1989. "Hume and the Paradox of Taste." In *Aesthetics: A Critical Anthology*, 2nd ed., edited by George Dickie, Richard Sclafani, and Ronald Roblin, 269–86. New York: St. Martin's Press.

Nafziger, James A. R., ed. 2012. *Cultural Heritage Law*. Cheltenham, UK: Edward Elgar Publishing.

Nafziger, James A. R., Robert Kirkwood Paterson, and Alison Dundes Renteln. 2010. *Cultural Law: International, Comparative, and Indigenous*. New York: Cambridge University Press.

Naraniecki, Alexander. 2010. "Neo-Positivist or Neo-Kantian? Karl Popper and the Vienna Circle." *Philosophy* 85 (4): 511–530.

Newton, Isaac. 1999. *The Principia: Mathematical Principles of Natural Philosophy*. Translated by I. Bernard Cohen and Anne Whitman assisted by Julia Budenz. Berkeley, CA: University of California Press. First published 1687 as *Philosophiae Naturalis Principia Mathematica*.

Peirce, C. S. (1896–99) 1955. "Logic as Semiotic: The Theory of Signs." In *Philosophical Writings of Peirce*, edited by Justus Buchler, 98–119. Mineola, NY: Dover.

Pollock, Anthony. 2007. "Neutering Addison and Steele: Aesthetic Failure and the Spectatorial Public Sphere." *ELH* 74 (3): 707–34.

Probst, Jörg, and Jost Philipp Klenner, eds. 2009. *Ideengeschichte der Bildwissenschaft: Siebzehn Porträts*. Frankfurt am Main: Suhrkamp.

Putnam, Hilary. 1975. "What Is Mathematical Truth?" In *Mathematics, Matter and Method: Philosophical Papers, Vol. 1*, 60–78. Cambridge: Cambridge University Press.

Quine, Willard V. O. 1969. "Epistemology Naturalized." In *Ontological Relativity and Other Essays*, 69–90. New York: Columbia University Press.

Ransom, John Crowe. 1941. *The New Criticism*. Norfolk, CT: New Directions.

Rawls, John. 1971. *A Theory of Justice*. Cambridge, MA: Belknap Press of Harvard University Press.

Read, Rupert J., and Kenneth A. Richman, eds. 2000. *The New Hume Debate*. London: Routledge.

Rheinberger, Hans-Jörg. 1992. *Experiment, Differenz, Schrift: Zur Geschichte epistemischer Dinge*. Marburg an der Lahn: Basilisken-Presse.

———. 1995. "From Experimental Systems to Cultures of Experimentation." In *Concepts, Theories, and Rationality in the Biological Sciences: The Second Pittsburgh-Konstanz Colloquium in the Philosophy of Science, University of Pittsburgh, October 1–4, 1993*, edited by Gereon Wolters and James G. Lennox with Peter McLaughlin, 107–22. Pittsburgh, PA: University of Pittsburgh Press.

———. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

———. 1998. "Experimental Systems, Graphematic Spaces." In Lenoir 1998, 285–303.

———. 2000. "Dimensionen der Darstellung in der Praxis des wissenschaftlichen Experimentierens." In *"Die Erfahrungen, die wir machen, sprechen gegen die Erfahrungen, die wir haben": Über Formen der Erfahrung in den Wissenschaften*, edited by Michael Hampe and Maria-Sibylla Lotter, 235–46. Berlin: Duncker & Humblot.

———. 2004. "Experimental Systems." *The Virtual Laboratory: Essays and Resources on the Experimentalization of Life*, Max Planck Institute for the History of Science, Berlin. Accessed 12 December 2012. http://vlp.mpiwg-berlin.mpg.de/references?id=enc19.

———. 2005. "Gaston Bachelard and the Notion of 'Phenomenotechnique.'" *Perspectives on Science* 13 (3): 313–28.

———. 2008. "Epistemische Dinge—technische Dinge." Filmed 2 July, Bochum Media Science Colloquium. Vimeo video, 58:37. Accessed 18 September 2012. http://vimeo.com/2351486.

———. 2010. *On Historicizing Epistemology: An Essay*. Translated by David Fernbach. Stanford, CA: Stanford University Press. First published 2007 as *Historische Epistemologie zur Einführung* (Hamburg: Junius).

———. 2011. "Consistency from the Perspective of an Experimental Systems Approach to the Sciences and Their Epistemic Objects." *Manuscrito* 34 (1): 307–21. Accessed 12 December 2012. http://dx.doi.org/10.1590/S0100-60452011000100014.

Roger, Jacques. 1997. *The Life Sciences in Eighteenth-Century French Thought*. Edited by Keith R. Benson, translated by Robert Ellrich. Stanford, CA: Stanford University Press. First published 1963 as *Les sciences de la vie dans la pensée française du XVIIIe siècle: La génération des animaux de Descartes à l'Encyclopédie* (Paris: Colin).

Rogoff, Irit. 2006. "'Smuggling'—An Embodied Crticality [*sic*]." *Transversal*, August. Accessed 12 December 2012. http://eipcp.net/dlfiles/rogoff-smuggling.

Ross, Stephanie. 2008. "Humean Critics: Real or Ideal?" *British Journal of Aesthetics* 48 (1): 20–28.

Rubinstein, Raphael. 2003. "A Quiet Crisis." *Art in America* 91 (3): 39–45.

Russell, Paul. 2006. "Moral Sense and Virtue in Hume's Ethics." In Value and Virtues: Aristotelianism in Contemporary Ethics, edited by Timothy Chappell, 158–70. Oxford: Oxford University Press / Clarendon Press.

Sachs-Hombach, Klaus, ed. 2005. *Bildwissenschaft: Disziplinen, Themen, Methoden*. Frankfurt am Main: Suhrkamp.

Schellekens, Elisabeth, and Peter Goldie, eds. 2011. *The Aesthetic Mind: Philosophy and Psychology*. Oxford: Oxford University Press.

Schliesser, Eric. 2008. "Hume's Newtonianism and Anti-Newtonianism." In Stanford Encyclopedia of Philosophy, Winter 2008 ed., edited by Edward N. Zalta. Accessed 12 December 2012. http://plato.stanford.edu/archives/win2008/entries/hume-newton/.

Schreibman, Susan, Ray Siemens, and John Unsworth, eds. 2004. *A Companion to Digital Humanities*. Oxford: Blackwell.

Seigel, Jerrold. 2009. "Selves without Qualities? Duchamp, Musil, and the History of Selfhood." In *The Modernist Imagination: Intellectual History and Critical Theory*, edited by Warren Breckman, Peter E. Gordon, A. Dirk Moses, Samuel Moyn, and Elliot Neaman, 24–54. New York: Berghahn Books.

Sessions, William A., ed. 1990. *Francis Bacon's Legacy of Texts: "The Art of Discovery Grows with Discovery"*. New York: AMS Press.

Shaftesbury, Anthony Ashley Cooper, third Earl of. (1714) 1999. *Characteristics of Men, Manners, Opinions, Times*. Edited by Lawrence E. Klein. Cambridge: Cambridge University Press.

Shapin, Steven, and Simon Schaffer. 1985. *Leviathan and the Air Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.

Sloan, Phillip R. 1999. "From Natural Law to Evolutionary Ethics in Enlightenment French Natural History." In *Biology and the Foundation of Ethics*, edited by Jane Maienschein and Michael Ruse, 52–83. Cambridge: Cambridge University Press.

Smith, J. C. 2012. "Darwin and Freud after Derrida: Is a Postmodern Sociobiogy Now Possible?" University of British Columbia, Faculty of Law. Accessed 12 December. http://www.law.ubc.ca/files/pdf/faculty/smith/Derrida.pdf.

Spolsky, Ellen. 2002. "Darwin and Derrida: Cognitive Literary Theory as a Species of Post-Structuralism." *Poetics Today* 23 (1): 43–62.

Suisky, Dieter. 2009. *Euler as Physicist*. Berlin: Springer.

Tanner, Jeremy, ed. 2003. *The Sociology of Art: A Reader*. London: Routledge.

Throsby, David. 2010. *The Economics of Cultural Policy*. Cambridge: Cambridge University Press.

Towse, Ruth. 2010. *A Textbook of Cultural Economics*. Cambridge: Cambridge University Press.

van Fraassen, Bas C. 1980. *The Scientific Image*. Oxford: Oxford University Press / Clarendon Press.

———. 1989. *Laws and Symmetry*. Oxford: Oxford University Press / Clarendon Press.

———. 2008. *Scientific Representation: Paradoxes of Perspective*. Oxford: Oxford University Press / Clarendon Press.

Velthuis, Olav. 2005. *Talking Prices: Symbolic Meanings of Prices on the Market for Contemporary Art*. Princeton, NJ: Princeton University Press.

Voltaire. 1784. *Traité de metaphysique*. In vol. 32 of *Oeuvres Completes de Voltaire*, 13–76. Kehl, Ger.: La Société Littéraire-Typographique. Republished by Google Books. Accessed 1 June 2013. http://books.google.co.uk/books?id=voMoAAAAMAAJ&pg=PP9#v=onepage&q&f=false.

Weber, Marcel. 2005. *Philosophy of Experimental Biology*. Cambridge: Cambridge University Press.

———. 2012. "Experiment in Biology." In *Stanford Encyclopedia of Philosophy*, Spring 2012 ed., edited by Edward N. Zalta. Accessed 12 December 2012. http://plato.stanford.edu/archives/spr2012/entries/biology-experiment/.

Wheeler, Michael, John Ziman, and Margaret A. Boden, eds. 2002. *The Evolution of Cultural Entities*. Oxford: Oxford University Press.

Wind, Edgar. 2001. *Experiment and Metaphysics: Towards a Resolution of the Cosmological Antinomies*. Translated by Cyril Edwards. Oxford: Legenda. First published 1934 as *Das Experiment und die Metaphysik: Zur Auflösung der kosmologischen Antinomien* (Tübingen: Mohr).

Wright, John P. 1983. *The Sceptical Realism of David Hume*. Manchester: Manchester University Press.

Young, Robert J.C. 2004. *White Mythologies: Writing History and the West*. 2nd ed. Abingdon: Routledge.

Zlomislić, Marko. 2007. *Jacques Derrida's Aporetic Ethics*. Lanham, MD: Lexington Books.

Zuss, Mark. 2012. *The Practice of Theoretical Curiosity*. Explorations of Educational Purpose 20. Dordrecht: Springer.

Epistemic Events

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By asking whether the work of Hans-Jörg Rheinberger is useful in communicating the experimental within the research structures being deployed by artists, this chapter reflects on producing knowledge through contemporary forms of arts practice. As a practitioner working in academia and running an independent art and research organisation, I examine the temporal dimension of epistemic processes that have emerged from the recent history of socially engaged practice. The aim is to explore these temporal dimensions within a discussion of epistemic practices that can simultaneously sustain critical futures for research practice both within and outside academic institutions.

INTRODUCTION

> This expanded field of relational practices currently goes by a variety of names: socially engaged art, community-based art, experimental communities, dialogic art, littoral art, participatory, interventionist, research-based, or collaborative art. These practices are less interested in a relational aesthetic than in the creative rewards of collaborative activity—whether in the form of working with preexisting communities or establishing one's own interdisciplinary network. (Bishop 2006)[1]

If we are to understand the value of critical art practices prevalent today, this outline by Claire Bishop might be a useful start. Even while omitting critical media art, it brings together a wide range of practices and, in asking what the creative rewards are, uses collaborative activity and communities of practice to pinpoint forms and values. This could be read as an acknowledgement of Pierre Bourdieu's (1993) definition of cultural capital, by means of which artists recognise the value of others' work through the currency of their ideas across a discipline. In recent publications by Bishop (2012a) and Shannon Jackson (2011), this recognition of value between artists in these new areas, whether manifested as artworks or as relational exchanges, has become accepted as the capital generated in a range of social art practices that are increasingly acknowledged as having acquired sustainability, longevity, and critical attention. As an aspect of this success, many have generated new mechanisms, forms,

1 This quotation is taken from a paper in which Bishop provides a theoretical criticism of relational aesthetics. However, the emergence of experimental work by artists such as Rirkrit Tiravanija, Liam Gillick, and others was identified by Nicolas Bourriaud (2002) as a way of describing social and relation activity within the confines of the museum. The argument is taken further by Hans-Ulrich Obrist, who likens the museum to a laboratory (see Obrist and Vanderlinden, 2001).

and "epistemic things" that are identifiable as having currency. The Office of Experiments' research not only uses such forms but also focuses on "epistemic things" as the *objects* of research. Before exploring this link, I would like to start by discussing the specifics by which "epistemic processes" are generated in art practice and analysing what is implied within the shift from the material to the temporal dimensions of research.

THE TEMPORAL DIMENSION OF SOCIAL FORMS

In his book *Toward a History of Epistemic Things*, Rheinberger (1997) uses the terms "epistemic things" and "experimental systems" to describe the arrangement of the science laboratory. Specifically, Rheinberger's (1997, 34) emphasis on the "local, social, technical, institutional, instrumental, and epistemic settings" of experiments provides some framing aspects for the experimental system that is of use to the artist, but falls short of what might be implied by the term "social" as a material at play within these experiments (see Latour 2005).

Rheinberger's historiographical analysis of knowledge development across a distributed laboratory network in biology and its potential has parallels with the ways in which artists now work outside their traditional space of production, the studio. For Rheinberger, differentiating between the roles of material things in experimental systems is fundamental to understanding how knowledge is produced as a result of the arrangement of these actors. In his work, there is an essential difference between material things that, as technical objects, provide the "experimental conditions," and epistemic things that are traced to produce knowledge: "Whether or not an object functions as an epistemic thing or a technical entity depends on the place or node it occupies in the experimental context" (Rheinberger 1997, 34).

In the conference proceedings to "The Shape of Experiment," which occurred in 2005, the conference organisers defined this arrangement of things in order to outline the shift from modern to postmodern forms and values: "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" (Schmidgen and Kursell 2006, 4). Here we can see how the "social" becomes constituted as a key element of the distributed experiments, as developed in science. Bruno Latour (2005, 64), referred to in the above quotation, describes the "social" as acting like a "tie," having a quality that is different but similar to "'material,' 'biological,' 'psychological,' and 'economical' connections'". As part of "actor network theory," the social is therefore a term that is dynamic: "a movement, a displacement, a transformation, a translation, an enrollment... characterized by the way it gathers together into new shapes" (ibid., 64–65). Ascribing this quality to the experimental, Latour asserts that all manner of things, whether they are machine or human, can have agency, creating "social

ties" technically or relationally. Notably, it can be argued that Latour suggests that these social ties are linked through temporal rather than material or spatial qualities. As post-studio practice has become synonymous with many forms of critical arts practice, it mirrors conditions observed by Rheinberger in science, in that it has transformed or been transformed by networked technologies—a linked network. In this sense, it would seem that we can use such transformations to examine "the thing" in art, particularly as art becomes social.

The Artist Placement Group (APG) provides a good case study for how this shift has occurred in art. I was involved in its most recent form, O + I (1998–2009), through study of its archives and specific instances of its practices.[2] In APG (prior to its dissolution), but also in some of the practices of O + I, we can see how art made a transition from its concern with the "artistic thing," an object with intrinsic value, towards a socially constructed "epistemic thing," an object with cultural, social, and epistemic capital. This transition marks the kind of "paradigm shift" declared by the artist John Latham, who specifically attempted to reframe the material and spatial nature of art, as well as its "objecthood," against more temporal concerns.

Developing an early cosmological view of the world, a grand narrative that was both modernist and universal in its ambitions, Latham derived his original ideas within the Institute for the Study of Mental Images (ISMI) in 1954 (Walker 2008, 8). Making a onesecond painting with a spray gun, as a mural for the founders of the ISMI in 1955, Latham recognised that the simple constellation of marks he created on a surface (the wall) in this short space of time could be elaborated into a view of the "the cosmos as a temporal score" (ibid.). Latham went on to develop the ideas associated with this incident and in discussions with Clive Gregory and Anita Kohsen as a theory of flat time (Macdonald–Munro 2004).[3] From this "discovery," a conventional observation, Latham made the translational development from proposing his own artwork, or "artistic things," towards "epistemic things" that were associated not with materiality but with the ability to describe his own ideas about time. As conceptual artworks, Latham's one-second drawings with spray cans, his performances, or his roller diagrams—all used to explain his theories—were described by Latham as "event structures," a formal organisation that was defined by temporal and not material dimensions.

The attention paid to the temporal by both Latham and Rheinberger in respect to knowledge is striking. At the start of *Toward a History of Epistemic Things*, Rheinberger (1997, 15) refers to Michel Serres's comparison of the history of science, "which does not unfold in time but on which time acts as an operator," to a meandering river. In thinking that knowledge as shaped by history is dynamic and flowing, Rheinberger also draws on Jacques Derrida's

2 I was a director of O + I (Organisation + Imagination), which replaced APG and was led by John Latham and Barbara Steveni. I also assisted both in the establishment of Latham's archive and house and in AHRC bids with Tate Britain to digitise the APG archive. I was a speaker, with Steveni and other directors of O + I, at Tate on its acquisition of the APG archive and at the exhibition *The Individual and the Organisation: Artist Placement Group, 1966–79* at Raven Row Gallery, London, in 2012.

3 One of the few people that Latham trusted to communicate his ideas was Ian Macdonald-Munro, his student when he taught at Central St. Martins.

concept of "supplementarity." He invokes this simply by referring to supplementarity as a concept of displacement, a displacement of things that can reconfigure everything. Later, returning to consider "a glimpse of an epistemology of time," Rheinberger (ibid., 181) illustrates how knowledge or the experimental system itself is caught up in a temporal dimension: "The multiplicity of experimental systems endowed with their own times, and of course, their rationales, shifting and drifting in an open horizon, constitutes a historical ensemble. Such ensembles escape the strong notions of social history such as linear causation, retroaction, influence, dominance, and subordination." This is an observation that parallels Latham's temporal analysis of art as composed of event structures and their roles in the historic project, past and present. While art is understood as either an object or a temporal or social entity, which can be a sculpture, a musical score, or an organisational structure, the term "event structure" alludes to the different kinds of time inherent in each. Understanding how the temporal characteristics, the "time-bases," of each event structure operate and constitute an ensemble was crucial to Latham's proposal regarding the production of knowledge. Latham asserted, however, that it was not scientists but artists, with their instinctual rather than rational approach, who could fully explore the temporal dimensions of event structures—not through the production of technical objects, but within the social context of the event structure, through what we might call an experimental system. He recognised that, since many "systems" or event structures operated with different time bases simultaneously, there was no such thing as an object or even linear time. Knowledge, in fact, was a construct of multi-temporality, a product of time; and, with this, subject to it.

Having helped to establish the Artist Placement Group in 1966, with Barbara Steveni, Anna Ridley, Barry Flanagan, David Hall, and Jeffrey Shaw, Latham shifted his attention to apply these ideas to the event structures that also form the context for social practices. While APG initially worked to secure funding from host institutions for artists who required material resources for the "objects" they made, the group also responded to changes in the international art scene, particularly the activities of Fluxus, and began to engage with the structure and organisation of social institutions, corporate entities, and government departments. In this process, Latham started to analyse the role of institutions and governments, political structures, social agents, and policy and development cycles, as they provided new contexts for his own practice with event structures.

Initially working together through social and discursive forums, the group developed a methodology that engaged critically with temporality. They placed artists not as "residents," who helped their hosts to communicate with or engage markets or to make sculptures, but as a form of consultant, making and analysing the value and hierarchy of the organisation through a durational feasibility study. Through this feasibility study they would evaluate the potential value of the placement and the values that should underpin the artwork. If all parties—artists and placement organisation—were in agreement about this process, they would draw together a contract for a period of work. The outputs

of this work were often not fixed. Increasingly, through Latham's assertions of his theory, APG started to become more concerned with the role of the artist as a temporal actor who was "incidental" to the organisational values in which they were placed. The development of the concept and workings of "the placement" led to work with other international art figures such as Joseph Beuys. Successfully engaging the German government in talks, they also placed artists inside the Scottish Office (Latham), in leading global companies such as ICI, and in British state organisations such as the National Coal Board and the Peterlee Development Board (Stuart Brisley). APG thus re-examined the role of the artist within a larger and pre-existing social laboratory or system, and the artist became known as an "incidental person."

In the discourse that surrounds the presentation of the work that was actually produced through the placements, it is clear that APG's material histories and artworks were much less significant than the discursive, socially engaged epistemic practices that surrounded the group itself (often arranged by Steveni, who was often overlooked as an artist during APG's lifetime). APG was indeed conscious of this fact, and when operating within the white cube or gallery in exhibitions such as *Art and Economics*[4] at The Hayward Gallery in London a range of methods for exchanging concepts and ideas was engineered. For example, as part of *Art and Economics* the group set up a meeting room as a "public sculpture" in which visitors could observe, or on occasion participate, in the discussions led by APG members. The development of these and other performance formats[5] started to include non-artistic incidental persons. It can be argued that this led to ruptures in the field of arts' operations (audience, spectator, social space, etc.) but also that it created new "epistemic events." The APG's role in the establishment of the "discursive" aspect of their art, which further included publishing many semi-legal documents, contracts, and processes, can also be seen to lead to a range of "epistemic events" whose temporal forms are to this day the basis for the structures used for the exchange of ideas between disciplines, cultures, and society,[6] specifically in relation to social arts practice. Arguably, by developing significant practices within institutions or concentrations of power, APG were able to draw upon material resources, as well as on theoretical resources, to develop a discursive and epistemic experimental system in multiple social contexts.

EPISTEMIC EVENTS

As the director of a collective practice concerned with new forms of experimentation beyond disciplines, the Office of Experiments, I would argue that the production of "epistemic things," as described by Rheinberger and Latour and as explored through the work of APG, provides a useful framework for

4 See Tate (2013).

5 Among these was a "between" format that allowed artists to use major gallery space between exhibitions. It was used by APG after their introduction to the format at Städtische Kunsthalle Düsseldorf. APG performed *Between 6* there in 1971. I also used the approach in April 2007 at South London Gallery with O + I and Critical Practice, Chelsea College of Art and Design.

6 For more information, see Bishop (2012b).

understanding other contemporary forms of networked, social, and critical practices with regard to their production of knowledge.

The role of technology in these developments is an unfolding and contested territory in art discourse and has unsurprisingly led to a re-examination of the "relational" dimensions of art's own production techniques in the work of figures such as Bishop and Bourriaud. In recent times we have also seen the term "media art" being critically examined, in a move towards "post-media" forms. In the online synopsis of the book *Media, New Media, Postmedia*, Dominico Quaranta (2010) quotes Inke Arns:

> The specific character of the media arts under post-medium conditions is today not the media, but their specific form of contemporaneity, their engagement on a substantive plane with a present bearing the strong stamp of electronic media and new technologies. This critical engagement does not take place necessarily by using these new technologies, but rather, art employs (almost) all of these possible media and techniques. This kind of media art is at the same time liberating itself from the compulsion to employ the newest technologies. It is ridding itself of the conceptual burden of the newness of the medium and is facing the challenge of art itself. It is finally growing up. (Arns 2008, 74)

To explore this idea further and to underline this point, I will use one brief example that captures key aspects of Arns's definition of post-media operations and extends the arguments developed around "epistemic events."

The Center for Land Use Interpretation (CLUI) draws upon the work of artists associated with land art. Intellectually (and spiritually), it is indebted in particular to Robert Smithson as the artist who breached first the material and then the conceptual boundary of practices, allowing for an expanded field of art that would eventually lead to an inevitable move across intellectual as well as physical landscapes. Since 1994, CLUI has worked to develop what Rosalind Krauss termed "Sculpture in the Expanded Field" (1979), the practice of not separating art from its context in a landscape or against architecture. Concerned not primarily with producing art but with producing knowledge, CLUI has been documenting sites and spaces and their use across the USA, a process that has led to the development of the American Land Museum, a virtual and physical collection of documents of facilities, ranging from nuclear to industrial sites, that are presented through different interpretive framings. Critically, this is not art in an expanded field, but artists operating in the expanded field of knowledge, which also represents the context and the space in which they present their work. CLUI operates remote desert research stations and mobile exhibition spaces, and does not care whether this work is seen in the Whitney Museum of Modern Art or in a trailer in the oil fields of Texas (White 2013a).

As developers of a model that seeks to create a stable and sustainable organisational structure, CLUI's forms of networked research have now been widely duplicated in the USA and beyond, acknowledged in some form by, for instance, Friends of the Pleistocene, the Institute for Figuring, and the Center for PostNatural History. In this respect, CLUI remains a defining example of

how epistemic things are developed within the broader context of an experimental system of art and how research and dissemination processes, such as digital archiving, interpretive layering, and spatial analysis, now happen across new technological networks—large-scale "experimental systems" outside universities or research institutions. Through discussions of boundaries, territories, and crossings, this new artistic research has enabled a new network, in new contexts, that operates at new material scales. CLUI has done this by identifying the temporal and social dimensions of what is largely a spatial practice, and by emphasising the social as a critical part of a non-hierarchical view of a subject—in this case land use. As Ralph Rugoff wrote of CLUI in his introduction to the publication *Overlook*: "In contrast to our culture of experts—the pundits, academics, and government analysts who regularly appear in the media to tell is what to think—the Center is a haven of amateur agnostics. Its members are specialists who specialize in non-specialization. Their approach is not so much multidisciplinary as nondisciplinary: it traces out an underlying logic that connects disparate fields and perspectives linking them to the common ground of land use and its interpretation" (Rugoff 2006, 39).

Since 2004, working with geologists, geographers of science and technology, archival researchers, and documentary practitioners to develop an open approach to fieldwork, I have helped to develop an independent research organisation that has worked with CLUI and has also drawn upon the ideas of John Latham and many academics, artists, and scientists. The Office of Experiments[7] (OoE) has used Rheinberger's definition of "experimental systems" in order to test multiple spaces in which research and knowledge have been developed. As with CLUI, we also work across disciplines and levels of expertise, so we pay very specific attention to forms that might yield "epistemic things" and to how the social materials of the experiment unfold. For example, we have been developing experimental fieldwork techniques to draw attention to the temporal dimensions of social practices as event structures.

One such experimental fieldwork technique is the "critical excursion." To borrow CLUI terminology, this is a spatio-temporal bus tour, in which information mediated from the archives of institutions is contrasted with visits to the perimeters and territorial edges of physical sites of interest. Critical excursions are also tied to a research logic that we employ, termed "overt research," that focuses on sites and spaces of research experimentation and intelligence not normally accessible to the public. Much like CLUI, we bring in amateur enthusiasts, activists, and independent researchers to lead and guide a dialogue around these subjects. Crucial, however, is an emphasis on the representation and dialogue developed through the use of factual and imaginary materials within socio-temporal structures—that is, factual films, conspiracy theory, rumour, and play. The success of these critical excursions is measured by the degree to which they become not only models for scrutiny of their subject but also, critically, a temporary space for dialogue and discourse that takes part between those undertaking research: experts, advisors, stakeholders and

7 For further information on Office of Experiments, see Flintham (2012); Scott (2010); Rowell and White (2011); White (2013b).

artists, and the object of research itself. Gail Davies (2010), an associate of OoE, reflected on the critical excursion titled Spaces of Secrecy and Technology and explored how the subject of enquiry crosses species and scales. Davies points out how elements of risk, liveliness, and diversity set the stage and how experiences, enthusiasms, and collectivities are both on-line and on the line: "The experiment is collective, but also necessarily open to contestation. Just as there is 'a suspicion of science as usual,' there is also a necessary suspicion of 'activism, art and theory as usual.' ... In science, social science, art and politics, the boundaries between methodologies of inquiry blur, there is no easy endpoint, rather a continuing process of reactive, iterative and generative experimentation (Thrift, 2008). The question remains open. Where does the experiment end?" (Davies 2010, 670).

I hope to have demonstrated that for many artists engaged in social or epistemic practices, being experimental is not merely a mode of operation, a system through which an artwork exists or might come into being. Within the context of post-studio practices and the contemporary institutions created by artists, designers, and others (digitally and physically), the development of the "social" has moved us beyond a term that simply identifies aspects of the discursive as described by Rheinberger and Latour or in the early work of APG. For artists engaged in experimental epistemic practices, the social is a temporal yet material component of these experiments that, in fact, allows small research-based organisations to sustain themselves through engagement with audiences at all levels, across different kinds of time, moving, to use a technical analogy, from the synchronous to the asynchronous. These blended digital and physical environments use temporalities and social forms to allow dialogues between disciplines and fields of research across territories, creating new knowledge in their wake.

Does this mean that in the future there will be an increasing role for experimental institutions such as these that develop new epistemic things within or in relation to our existing institutions of research and methods and forms of dissemination? I would argue that this is largely irrelevant as the emergence of a new space of research is upon us—a dynamic yet temporal space, as topological as it is digital and geographic, geopolitical and ephemeral. For those operating in this space, the socio-temporal dimensions of the epistemic events underpin the research process and its dissemination, simultaneously addressing the exterior and interior, expert and amateur, and issues of access to classified and open information, and continually constituting "a movement, a displacement, a transformation, a translation, an enrollment... characterized by the way it gathers together into new shapes" (Latour 2005, 64–5). This is evident in the forms used by numerous groups and research initiatives as they develop new knowledge across institutional and non-institutional situations, disciplines, and subjectivities. These specific practices, in which artists, architects, academics, activists, and independent researchers come together, are levelling the field. Some may be working in academic contexts, others may be engaged in artistic contexts, but all are already contributing to independent, sustainable knowledge practices that further establish and argue these claims.

REFERENCES

Arns, Inke. 2008. "Und es gibt sie doch: Über die Zeitgenossenschaft der medialen Künste / And It Exists After All: On the Contemporaneity of the Medial Arts." In *Hartware MedienKunstVerein 1996–2008*, edited by HMKV (Susanne Ackers, Inke Arns, Hans D. Christ, and Iris Dressler), 66–78. Bönen, Ger.: Kettler.

Bishop, Claire. 2006. "The Social Turn: Collaboration and Its Discontents." *Artforum*, February. Accessed 5 May 2013. http://www.artforum.com/inprint/issue=200602&id=10274.

———. 2012a. *Artificial Hells: Participatory Art and the Politics of Spectatorship*. London: Verso.

———. 2012b. "Incidental People: APG and Community Arts." In Bishop 2012a, 163–91.

Bourdieu, Pierre. 1993. *The Field of Cultural Production: Essays on Art and Literature*. Edited by Randal Johnson. New York: Columbia University Press.

Bourriaud, Nicolas. 2002. *Relational Aesthetics*. Translated by Simon Pleasance and Fronza Woods with Mathieu Copeland. Dijon: Les Presses du Réel.

Davies, Gail. 2010. "Where Do Experiments End?" *Geoforum* 41 (5): 667–70.

Flintham, Matthew. 2012. "The Military-Pastoral Complex: Contemporary Representations of Militarism in the Landscape." *Tate Papers* 17 (Spring). Accessed 13 June 2013. http://www.tate.org.uk/research/publications/tate-papers/military-pastoral-complex-contemporary-representations-militarism.

Jackson, Shannon. 2011. *Social Works: Performing Art, Supporting Publics*. Abingdon, UK: Routledge.

Krauss, Rosalind. 1979. "Sculpture in the Expanded Field." *October* 8 (Spring): 30–44.

Latour, Bruno. 2005. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.

Macdonald-Munro, Ian. 2004. "Introduction to Flat Time." TheLeastEvent.com. Accessed 17 June 2013. http://www.theleastevent.com/introduction.htm.

Obrist, Hans-Ulrich, and Barbara Vanderlinden, eds. 2001. *Laboratorium*. Antwerp: Dumont / Antwerpen Open / Roomade. Published in conjunction with the exhibition of the same name organised by Antwerpen Open and Roomade in collaboration with the Provincial Museum of Photography, shown at various venues in Antwerp.

Quaranta, Domenico. 2010. "Media, New Media, Postmedia: English Abstract." *Media, New Media, Postmedia* (blog). Accessed 3 May 2013. http://medianewmediapostmedia.wordpress.com/english-abstract/. Published in conjunction with *Media, New Media, Postmedia* (Milan: Postmedia Books, 2010).

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.

Rowell, Steve, and Neal White. 2010. "Secrecy and Technology Bus Tour, Office of Experiments." Accessed 17 June 2013. http://www.artscatalyst.org/projects/detail/SecrecyTechnologybustour/. Published in conjunction with the critical excursion *Cold War Spaces of Secrecy and Technology*, devised by the Office of Experiments.

Rugoff, Ralph. 2006. "Circling the Center." In *Overlook: Exploring the Internal Fringes of America with the Center for Land Use Interpretation*, edited by Matthew Coolidge and Sarah Simons, 35–41. New York: Metropolitan Books.

Schmidgen, Henning, and Julia Kursell. 2006. "The Shape of Experiment." In *The Shape of Experiment*, edited by Henning Schmidgen and Julia Kursell, 3–7. Max-Planck-Institut für Wissenschaftsgeschichte. Accessed 22 January 2012. http://www.mpiwg-berlin.mpg.de/Preprints/p318.pdf.

Scott, Peter. 2010. "Office of Experiments." *Blueprint*, March: 54–60.

Tate. 2013. "APG: Artist Placement Group—Chronology." Tate, Online Resources. Accessed 3 June. http://www2.tate.org.uk/artistplacementgroup/chronology.htm.

Thrift, Nigel. 2008. "Re-Animating the Place of Thought: Transformations of Spatial and Temporal Description in the Twenty-

First Century." In *Community, Economic Creativity, and Organization*, edited by Ash Amin and Joanna Roberts, 90–121. Oxford: Oxford University Press.

Walker, John A. 2008. "The Spray Gun and the Cosmos: John Latham's Spray Gun Paintings of the 1950s." In *John Latham: The Spray Gun and the Cosmos*, edited by Laurent Delaye and Richard Saltoun, 3–30. London: Delaye Saltoun. Published in conjunction with the exhibition of the same name, shown at Delaye Saltoun, London.

White, Neal. 2013a. "Experiments in the Expanded Field of the Archive." In *All This Stuff: Archiving the Artist*, edited by Judy Vaknin, Karyn Stuckey, and Victoria Lane, 45–61. Faringdon, UK: Libri Publishing.

———. 2013b. "Office of Experiments, Experimental Ruins: West Edition." The Arts Catalyst. Accessed 17 June 2013. http://www.artscatalyst.org/projects/detail/ExperimentalRuinsWest. Published in conjunction with the critical excursion and artwork *Experimental Ruins: West Edition*, devised by the Office of Experiments.

Forming and Being Informed

Hans-Jörg Rheinberger
in conversation with Michael Schwab

Hans-Jörg Rheinberger spoke with Michael Schwab on 15 January 2013 in his office at the Max Planck Institute for the History of Science in Berlin.

EXPERIMENTAL SPIRIT

MICHAEL SCHWAB: *In a 2012 paper titled "Experiment, Forschung, Kunst" (Experiment, Research, Art), you talk about "experimental spirit" as a complement to experimental structure (Rheinberger 2012b, 13). Can you elaborate on what you mean by "experimental spirit"?*

HANS-JÖRG REINBERGER: There are two aspects that appear to me to be important with respect to what I call "experimental spirit." This is the first, and it begins with a caveat. One usually associates "spirit" with spirituality, a purely mental activity. However, in my understanding of "experimental spirit," the interaction of the experimenter with his or her *material* lies at the centre. If one is not immersed in, even overwhelmed by, the material, there is no creative experimentation. In the course of the interaction with the material with which one works in an experiment, the material itself somehow comes alive. It develops an agency that turns the interaction into a veritable two-way exchange. It's both a forming process and a process of being informed. The experimental spirit has a haptic quality. "Haptic" here points beyond mere sensory impression; it carries an epistemic connotation.

What is the second aspect that you associate with "experimental spirit"?

The second aspect is related, and it has to do with the focus on science as *practice*, as compared with the focus on science as a theoretical system. Experimental spirit means, to state it in traditional language, a plea for an inductive rather than a deductive attitude —although this is not my vocabulary.

So, do you reject Popper?

There are a lot of very interesting things in Karl Popper's major early book, *Logik der Forschung*, published in 1935, which was only translated a quarter of a

century later, when it appeared as *The Logic of Scientific Discovery* in 1959. Popper does actually, in this book, speak about what Hans Reichenbach (1938) called the "context of justification," and not the "context of discovery." To be sure, Popper conceives of science as a dynamic process, not as a system of propositions. However, despite this research-friendly, forward-looking attitude, he shares a backward-looking attitude with the brands of philosophy of science that were characteristic of the first half of the twentieth century. In short: theory first. With Popper, this attitude took the form of "hypothesis first." Laboratory work comes second. The experimenter has to try hard to achieve what the hypothesiser would like to see. While I don't want to get rid of theory in empirical science, I nevertheless propose a reversal of poles: science is first and foremost a practical activity, although a theoretically laden one. This activity comes in a huge variety of guises. What unites them is that they are, on the whole, particular kinds of epistemic engagements with the world. This, of course, means that science has to be seen as a process deeply inserted in the materiality of our world, a collective engagement that cannot be reduced to the ingenious activity of an individual spirit who has the last word. This also means getting rid of the age-old thinking about *Erkenntnistheorie* as being about an I, an ego, a subject that tries to cast a theoretical net over an object. Instead, let us be a little bit more humble and see the experimenting subject as engaged in an activity that has, to put it in Ian Hacking's (1983, 150) words, "a life of its own," and one that is in need of many good eyes to see and many good ears to hear. Let us get rid of what could be called the tyranny of the subject.

What is the role of the subject as you describe it in the generation of knowledge?

Every experiment is about future. And the hand is the carrier of that future. This is the reason why I reproach the epistemological tradition for having narrowed down the notion of experiment to a matter of mere testing. If the future is dealt with in the classical epistemological tradition, it's always in the theory, for example, as prediction. My counter-position is that the future is in the experiment, and experimenting is about handling and engaging.

At the same time, experimentation displays a very special kind of engagement. On the one hand, an experiment is designed to exclude the experimenter as a subject from what is going on. On the other hand, paradoxically, to be able to do that you need closeness in order to arrive at the point where you can efface yourself in the experimental process and delegate the interaction to the bits and pieces of matter you are working with.

So you'd say that when somebody learns the experimental spirit, he or she also has to learn a type of handling?

Yes. Laboratory education does not happen from one day to the next. It is a protracted process. It usually takes years of engagement with a particular material in order to arrive at the kind of "extimacy," to use Jacques Lacan's (1986) wonderfully appropriate expression, that makes you a good experimenter.

Do you see a problem with Polanyi's notion of "tacit knowledge," which you refer to in Toward a History of Epistemic Things *(1997, 77–78), in particular in respect to a future that seems to exceed what we may tacitly know?*

Michael Polanyi makes a very interesting and good point with his idea about the uncircumventability of tacit knowledge. He is completely right to point out that you can't make everything explicit. There always remains something that you cannot logically resolve when you practise your trade as a scientist. His argument allows one to detach oneself from the logical positivist tradition and, with it, from the belief that science takes place at the level of language and more narrowly in the realm of logic. Polanyi made a very good point in his time, but I think we now have to go beyond that. He basically treats tacit knowledge as a residual category; but we should also acknowledge its prospective potential.

In the history of art, Marcel Duchamp, at the beginning of the twentieth century, could claim to have given up what he termed "retinal" painting. This signalled to some that the practice of making and the dirty handling of stuff had lost importance while conceptual practices moved into the foreground. Might this run in parallel with developments in the history of science?

With this, Duchamp is very much in harmony with the philosophy of science of his time. Historically, it *is* strange that, on the one hand, the nineteenth century was a century in which there was an explosion of experimental and empirical science, spreading out in a plethora of different disciplines, while on the other hand, the accompanying theoretical reflection shied completely away from the practical aspects of science and established itself in the sublime realm of theory. This counter-movement in epistemology to the actual development of the sciences appears strange at first sight; it may well hang together with the age-old, continuing struggle between science and religion over the authority to tell the truth. But this would be another discussion.

In a different text, you speak about the importance of "a sharp sense for secondary sounds" (Rheinberger 2010, 5, my translation). Does this imply that the experimental spirit enters the experimental situation from its margins?

If you want to be a productive researcher, you have to conduct your experiments in such a way that you can be surprised by the outcome, so that unexpected things can occur. This only happens if, on the one hand, experiments are precisely set up but, on the other hand, are complex enough to leave the door open for surprise. The magnitude of such surprises is itself constituted in a recursive or iterative loop. It doesn't expose itself in a flash of enlightenment at one particular point in time. That is how people who have effected major breakthroughs in science usually depict their own achievements in hindsight, which I think is due to a self-stylisation that can only come after the fact. The surprises, when they show up for the first time, are of a minor magnitude, and

may even make their appearance as contaminations, which is why they often tend to be overlooked. The experimental spirit lies precisely in not overlooking these small effects.

EXPERIMENTAL SPACE

In what kind of space does experimentation take place?

Today, science is predominantly carried out in all kinds of laboratories. Even field-science has become laboratory-shaped. Laboratories are semi-closed spaces—"esoteric" spaces, to put it in the words of Ludwik Fleck (1979)—full of jargon and opaque to everyday experience. An outsider no longer understands what goes on there. If you really want to understand what drives the sciences from within, you have to open these research boxes, these islands of "access to an emergence," as Gaston Bachelard (1949) put it. It is not enough to look at the sciences from the point of view of the dissemination of their results, for instance, or of the impact of economic interests, and so on. Research is a highly complex thing in itself. In art, we are, I think, confronted with a similar situation and thus must not fall prey to the idea that we can understand either the sciences or the arts from an altogether exoteric perspective, although the exoteric belongs to them as well.

How heterogeneous are those semi-closed spaces?

As far as the notion of space is concerned, one obviously has to narrow it down and also historicise it. All the categories I use are historically infused. Without considering this aspect, one misses the core of the attempt. If we talk about spaces of knowledge-acquisition from a historical perspective, we realise that the laboratory as a space of experimentation is a relatively recent development. For seventeenth- and eighteenth-century natural history, one of the predominant spaces of knowledge-acquisition was, for instance, the botanical garden, while one of the main instances of knowledge acquisition in the medical realm, at least from the end of the eighteenth century right up to our days, has been the clinic. Thus it has to be said that the experimental laboratory is one epistemic space among others, which means that epistemic spaces themselves come in a historical and contemporary multiplicity. That multiplicity, or heterogeneity, repeats itself fractally, if one considers the microstructure of an epistemic space such as the laboratory. A counter-example would be a Taylorist industrial production process, where you have a very clear division of labour and where every part of the process fits neatly with the rest. This is not the way laboratories are constructed. Laboratories are much closer to what Claude Lévi-Strauss (1962) characterised as "bricolage." If you look at any particular piece of laboratory equipment, you will see that it is constructed from a lot of ad-hoc arrangements that make it work in a local setting. You couldn't even export it to the next building—it might no longer work there. This idiosyncrasy of the laboratory is a very central aspect of experimental work, of creative experimental work.

What are the particular spatial conditions that allow for epistemic phenomena to occur? Would a word such as "density" or "saturation" be appropriate to convey how those minute moments and events seem to pull the experiment together?

I think the notion of density is an appropriate description, or perhaps "thickness," which reminds one, of course, of Clifford Geertz (1973). "Thick description"—a notion Geertz applies to anthropological narratives—tries to keep present all the different aspects that go, for instance, into the everyday life of a population in a village in the north of Mauritania. One could describe the scientific work carried out in a laboratory as an enactment of epistemic thickness. The experimental situation in the empirical sciences is usually characterised by theoretical under-determination and by material over-determination. That is the situation in which the scientific spirit has to engage itself. I think notions such as densification, oversaturation, or condensation might express this. Alternatively, one could say that laboratories are spaces of heightened awareness.

Are some technical objects just in the background, while the closer one gets to an epistemic situation, the more attention needs to be paid to the technical objects that are implied?

In *Toward a History of Epistemic Things* I wanted to convey the idea that the experimental process plays out a dialectic between epistemic things and technical objects, and that there exists a functional relationship between them rather than a substantial one. Epistemic things that have reached a certain point of clarification can be transformed into technical objects—and vice versa: technical objects can become epistemically problematic again. The technologies with which one works are normally used as black boxes; they can, however, be reopened and become things of epistemic interest. It was this dialectic between the epistemic and the technical that appeared to me—and still appears to me—to be at the core of the scientific process of experimentation. The technical object and epistemic thing respectively are the material correlates to the interplay between stability and change, which keeps the experimental process intrinsically open to the future, although, or even because, full use is made of earlier acquisitions. In an experimental system each sort of thing is articulated with the other. If one now tries to characterise what such a laboratory space is made up of, one can certainly introduce a good number of further specifications related to its technical setup. The electron microscope is a good example. The magnification power of the instrument might be at the centre of one's experimental work; but in order to be able to use it, one needs an infrastructure that goes way beyond the instrument and the experimental probe to be inserted into it. There has to be a continuous high-voltage power supply, and the instrument needs a special, solid foundation without which one can't get good pictures, and so on. So there is, from the instrument, a continuous expansion right into the architecture of the laboratory space.

In the history of art, technical objects have come to prominence in debates around the specificity of media. In contrast to this, it seems to me that in the scientific context, technical objects may simply be looked at as productive instruments that in comparison leave much less of a mark on the object being produced, making it less necessary to conceptualise outcomes around and dependent on these instruments. Is this a fair point to make?

There is a widespread attitude among scientists—in particular when they attempt to convey what they do to a larger audience—that makes these instruments tend to disappear from sight. They appear to be there just in order to look through; they are not thick. Such assumed transparency contributes to the neglect of the material and practical side of the process of scientific knowledge acquisition. We could speculate about why the "spontaneous philosophy"—to use a term of Louis Althusser's (1974)—scientists apply when they reflect upon their own work almost always points in this direction. However, in science studies over the past three or four decades, with their focus on the practical aspects of doing science, of science in the making, these media have become "untransparent." They have acquired a presence of their own and are being thought of as not just enabling scientific knowledge acquisition but also determining what can be known and what not. Seen from a media perspective, one could even go so far as to claim that all these instruments used by the sciences are the media without which they would never even be able to get at their bits and pieces of knowledge. A whole world would be foreclosed to them—and to us—had we not this *Zwischenreich der Medien* (in-between kingdom of media) that has grown overwhelmingly massive in the course of the last 150 years. Today, scientific instrument development and construction has even become a significant part of advanced industrial production on a global scale, so it has achieved an equally massive economic presence.

It is important to develop an awareness of the thickness or untransparency that comes with the usage of heavy instrumentation. Unconsciously living in such a media landscape has potentially disruptive effects on the production of science. I think there is an ad hoc awareness of the mediatedness on the part of the scientists in the laboratories, but I find it interesting—and intriguing—that as soon as scientists go public, they have a strong tendency to leave all that behind and to convey a picture of what they are doing as if the instruments were absent—or transparent, for that matter.

In order to speak to the public, scientists may need to sacrifice thickness, or différance*, as Derrida ([1976] 1997, 60; 1982) termed it in relation to language.*

Language is a medium as well, and so is written language—even more so. It comes with its own thickness, and it comes in grades. Writing up, tracing, sketching, is part and parcel of the experimental process. The protocol, in a way, belongs right inside the experimental process—it is an integral part of it; it participates in the thickness of the experiment. The research article, printed in a journal, has gone through a fairly regulated process of purification, but still reflects the experimental goings-on. The textbook in turn abstracts from

the experiment; it is completely fixated on results. The public speech of the scientist, finally, we could say, is as far away from the laboratory as you can get.

Is the "patchwork," as you call it (Rheinberger 2012a), that makes up empirical science actually also an experimental system where the "patches" on a higher level function like technical objects?

Experimental systems don't come in isolation. As a rule, they are part of broader landscapes, or cultures of experimentation. They form ensembles with a patchwork structure. The *in vitro* protein-synthesis system described in *Toward a History of Epistemic Things*, for instance, was part of a broader culture of biological *in vitro* experimentation that was already taking shape at the beginning of the twentieth century. Patchworks of experimental systems have a peculiar, semi-permeable structure. On the one hand, they are characterised by a certain circulation of materials, research technologies, and researchers among the patches. On the other hand, the patches retain a certain identity; they don't fuse with each other, they remain idiosyncratic generators of novelty. But I would be cautious about seeing experimental systems as technical objects that themselves constitute a higher level of creating novelty. I prefer to characterise this higher level as an experimental culture. Its structure feeds back into its elements, but there is no mimicry between the levels.

Has experimentation the way you describe it affected our culture at large? If yes, has this become problematic, in particular, if one looks at how corporations and governments "experiment" with economic realities?

There is a long and on-going sociological discussion about our modern "risk society" (Beck 1992; Krohn and Krücken 1993). And there is a more recent discussion about societal experimentation on a "real-time" scale (Groß, Hoffmann-Riem, and Krohn 2005). In our societies, we are constantly confronted with economic, social, political, cultural, and technical decisions that come with unintended, or unthematised, consequences. They equally ask for permanent reorientations. As far as new technologies are concerned, their development is usually connected to scientific experimentation. But society, for that matter, is not to be compared with a *scientific* laboratory. That would lead us into a technocracy, if not scientocracy. However, democracy as such is a permanent *political* experiment in which many different forces interact in agonistic and antagonistic ways. Fleck (1983) has even argued that our modern sciences with their openness and at least potential accessibility for everybody are a role model for a democratic process. Be that as it may, the modern sciences and democracy actually are historical co-products and ideally should be resources for each other.

TECHNOLOGY

Can any type of activity and any technology that helps to stabilise epistemic phenomena become part of an experimental system? What, then, about disciplines and disciplinary boundaries?

Experimenters are usually opportunistic in their use of research technologies. As far as disciplines are concerned, they are strongly connected to an institutional perspective. For a long time, the history of disciplines was a main focus of the history of science as a whole. While there continues work to be done in this direction, my approach was a different one. I wanted to do a kind of bottom-up history. Therefore, my starting point was experimental systems with their immediate surroundings. As I have said, experimental systems have a life of their own, and this life must be characterised in all its facets. Going one step further and conceiving of something like ensembles of experimental systems was the next obvious step upwards to understand fields or areas of scientific activity as structures of their own, without necessarily implicating the institutional aspects that disciplines carry with them. These ensembles or patchworks of experimental systems—experimental cultures—can become historically prominent or fade into the background and become marginal again without necessarily coinciding with disciplinary boundaries.

What may be the current role and value of disciplines?

Disciplinarity comes in different degrees. One would have to work much more historically on this topic, but it appears to me that there was a time in the development of our Western sciences—particularly in the nineteenth and early twentieth centuries—when we had processes of differentiation in the sciences that resulted in a host of different disciplinary ramifications and reifications. All these specialties tried to demarcate themselves from one another by more or less clear-cut boundaries. Much of the development of the natural sciences in the twentieth century has tended to undo these boundaries again, first in the form of hybrid disciplines such as biochemistry, biophysics, or even biophysical chemistry. When it comes to characterising what happens at the research fronts today, even these disciplinary boundaries no longer appear to be so important; sometimes they even act as impediments. Usually, if you have a research problem in these areas of inquiry, disciplines function as resources, but they no longer define the boundaries of the research problems themselves.

What is the role of institutions in enabling or disabling the formation of certain phenomena—that is, who is driving the development of experimental cultures?

I believe that in the long run the sciences are best served if one lets them be driven by themselves from below. Institutions are at their best if they don't prevent this drive. The power of institutions to shape experimental systems and experimental cultures top down is limited, as historical experience shows.

What can and must be done socially and politically is to create a frame, an academic environment, in which the self-correcting power of the sciences can unfold within the social and ethical limits that societies consider to be their standards. These standards themselves are under constant negotiation, to which of course the development of the sciences contributes its share.

You wrote (Rheinberger 2012a, 38) that the nineteenth century displayed an eigenideologischer Überschuss *(self-ideological excess) that the twentieth century replaced with the pragmatics of technology. In the context of such an ideologically determined nineteenth century, doesn't a notion such as "technical object" limit the analysis to an aspect that only became important in the twentieth century?*

The very term "technical" is in need of critical scrutiny and differentiation. We could here return to Bachelard (1949), who claims that what he calls "application" belongs to the very core of modern science. This means that a particular relation between epistemicity and technicality would have operated from the beginning of what we consider to be modern science. What became, in addition, more and more important in the course of the nineteenth century and even more so in the twentieth century is that technicality acquires much bigger contours; big technical systems have come to shape and reshape our everyday reality (Mayntz and Hughes 1988).

How can one approach a notion such as "technical object" from an arts perspective given that not all art engages with technology?

When one talks about "objects," one is always in danger of falling prey to reifications, in particular if one talks about technical objects. What I mean, basically, when using this pair of concepts—epistemic things, technical objects—is that there is an irreducible interplay between identity (the technical) and difference (the epistemic) in our processes of knowledge-acquisition. This also means that there is, and remains, an intimate relation between epistemicity and technicity to science as a whole, at least as it has been operating over a period of some four hundred years in our Western countries.

While the term "object" carries some definiteness with it, there is something indefinite about "thing." For me, the choice of the notion of epistemic *thing* is tightly bound to this constitutive vagueness, while the choice of the notion of technical *object* is bound to its being more or less clearly delineated.

Might a focus on technicity be problematic as art moves into the epistemic realm?

I am not a friend of tight homologies. It is very clear that there is no one-to-one homology between scientific and artistic activity—otherwise these two realms would collapse into each other anyway. We also need to be aware of perhaps irreducible differences while nevertheless working on a conceptual framework in which to talk about these differences and bring them into the realm of comparability.

Let us consider the art market for a moment. On the one hand, it constantly re-evaluates works of art of the past. On the other hand, as far as art production is concerned, it has a drive into the future. You're bound to do something new with respect to what has been there already. There clearly is this aspect of reaching out into the future and an exploratory element in artistic activity that is valued by the market. Whether the dialectics between epistemic things and technical things so characteristic of experimental science can be used as a point-by-point description of how art reaches out into the future, I don't know. Probably one will encounter limits that require other, or additional, conceptual frameworks.

While the art market is important to many artists, much artistic research seems also to critically distance itself from that market. Are there similar tendencies to be observed, for example, in nineteenth-century science?

We tend to use historical generalisations and talk about "the science" of "the nineteenth," "the eighteenth," or "the twentieth century" in our conversation, but we should be careful not to overstate it. The life sciences, for instance, as compared to the physical sciences of the nineteenth century, may well have operated according to a different stage of development. We should be careful about using the term "science" in the singular and, instead, look at the whole epistemic enterprise as an intrinsically pluralistic one.

There's another generalisation that should be treated with caution. When we talk about the kind of knowledge claims that scientists make, we should explicitly talk about "scientific knowledge," because it is clear that there are also knowledge claims associated with artworks, for example. Knowledge is being produced in music and literature and in other areas of culture, but the way it articulates itself is qualitatively different from the way knowledge claims are articulated in the sciences. Even within the sciences you have quite a number of different ways of making knowledge claims—think of the practices of mathematics versus those of the experimental sciences. There are lots of forms of knowledge around us, in everyday life as well as within the horizon of artistic production. These knowledges in one way or the other hang together, but they do not coincide. In recent history of science there is an increasing tendency to envisage a history of knowledge (*Wissensgeschichte*) and no longer keep the history of science (*Wissenschaftsgeschichte*) apart from the rest of knowledge. Knowledge effects have a much broader distribution in our intellectual life, and that should be taken seriously.

And, after all, why should "research" be restricted to scientific knowledge? This is a limitation that I don't think is justified. Nevertheless, we have to take note of the fact that within the last two hundred years, "research" has been connected, and more and more restricted, to scientific knowledge-production. I think we should arrive at a wider notion of what it means to do research—in terms of searching processes that can of course be different in different areas.

Would you say that the intensified focus on technology that you described as characteristic of the twentieth century sciences has conditioned the types of exploration that can be chosen?

I am not sure that this is really the case. Of course you can say that the environment of these exploratory spaces has become highly populated with all sorts of bits and pieces of technology that, for instance, a chemist at the beginning of the nineteenth century couldn't even have imagined—an electron microscope, an ultracentrifuge, for example. In that sense, the arsenal on which you can draw in a particular research process is incomparably more technically sophisticated than, let's say, 150 years ago. They form a technically more sophisticated and therefore also more constrained environment. On the other hand, these technologies don't act only as constraints. Through their very multiplicity, they create options and possibilities for interstices and things to eventually show up that, without them, never would have shown up and wouldn't even have been imaginable. There is thus a proliferation of technical boundaries, to be sure, but I don't see an "over-technologisation" of the research process as a whole that would ultimately lead to the disappearance of the epistemic dimension altogether.

Similarly, in the context of science, may research that depends on non-propositional modes of communication be disadvantaged?

Historically it is correct that in certain areas of science texts have been—and continue to be—the dominant form of communication, but there is a development within the different sciences over time. Sometimes the textual and the formulaic becomes less prominent, sometimes it becomes more prominent. Sometimes the visual becomes less prominent, sometimes it becomes more prominent. In the life sciences, even in the molecular ones, the visual has plainly gained in prominence in the past half century. When I studied biochemistry in the 1960s the textbooks abounded in text and formulae. If you look at a molecular genetics textbook of today, text is reduced to a minimum, and formulae, if at all, are mostly used in connection with overwhelming sequences of cartoon-like drawings and computer images.

GRAPHEMATICITY

You distinguish between a graphemetic space of inscriptions and traces and a space of representation in science. The graphematic space seems to include, for example, drawings or graphs but not words.

Indeed, words don't play a big role in the space of graphemes, of inscriptions. It's the traces that count here.

You argue that traces in the graphematic space are differentially reproduced—and not represented—in the discursive space of representation. I am not sure, however, if you conceive of those spaces as co-original, since it seems to me that you prefer the materiality of the former. If I compare this to the arts, it may be claimed that the space of material encounter—the studio—where an artist presumably engages his or her subjectivity is actually a reconstruction and a simplification that historically was used to support the idea of the artist as genius. Could it be that an emphasis on materiality is, perhaps for other reasons, also problematic in the history and theory of science?

I wouldn't talk here about subjectivity. If anything, I would talk about uniqueness. For instance, you wouldn't organise a publication according to the principles that you use in your notebook, because the latter is meant to be a trace collector that helps you organise your bench work. A publication is thus secondary to the laboratory activity, without which of course it wouldn't exist, but it also has to be organised in such a way that it conveys knowledge to a potentially global community. If you want to continue your work as a scientist, the optimal thing that can happen to you is that somebody else picks up what you have been doing and integrates it into his or her own work. Your reputation as a scientist depends on these acts in the space of representation without which your graphematic activity would also come to a halt. In that sense, the representational space is as necessary as the graphematic and, in a way, probably even co-originary—you can't separate them.

My emphasis on the graphematic space—you may look at it as a bias—is due to the necessity of getting away from looking at science only from the historically privileged perspective of the space of representation that has dominated the history of science so far. What have historians of science largely relied on when doing their work? Published papers.

One lesson I take from the history of art is the shift from the processes of making as the primary site of art, to criticism, discourse, and ultimately, the market. As a consequence, what is made and how it is made may now be looked at as secondary.

We might have to do with two historically counter-running correctives. I think it is misleading to shape the whole question into one of primacy. Even if I sometimes use the notion of "originarity" in connection with traces, for instance, one has to be very cautious about it. It is helpful here again to have recourse to Derrida ([1976] 1997), who suggests that we free the question of origin from a teleological framework. Everything is always already in the midst of things, where the question of what is primary and what is secondary loses its sense and where things interact with one another forward and backward.

It's always good to think about the dichotomies we have on the table. One such dichotomy that has come up repeatedly in our conversation is that between the epistemic and the technical as a way to make sense of the experimental process. There is, as I said, a dialectic between epistemicity and technicity and a constant oscillation between looking at something as being technically defined and looking at something as being epistemically open. One and

the same entity can appear, or be handled, in a certain context as a technical or as an epistemic entity. As I said it is not the materiality of the entity that defines whether it's a technical object or an epistemic thing. Another dichotomy is that between materiality and—not quite ideality, but other, less heavily material forms of being-there: for instance, graphematicity. Obviously there are different regimes of materiality. In the process of an experiment, you have the material level of the arrangement of the experiment, but then you have a layer of graphematicity. Basically, what you produce in the experiment is traces, very often indexical ones that are somehow connected to the process under investigation. Usually those traces are of a volatile character. If you want to preserve them for further work, you have to find ways of stabilising these traces. In this process of transformation, which we can address as a transition from traces to data, you gain durability and lose materiality, as so lucidly described by Bruno Latour (1988, 1993). You come to a level that in one way or another ends in paperwork, inscriptional items still very near to the experiment and pretty far from a scientific article. The arrangements, rearrangements, interconnections, and transformations of traces that derive from the experiment are part and parcel of the knowledge-production process. Knowledge effects don't automatically spring out of the experiment. There is a level of creativity involved in the production of this second-order reality that goes along with experimentation.

What does matter or material mean to you, in particular when it is contrasted with form? Why do you refer to George Kubler's The Shape of Time *([1962] 2008), an art historian who focuses on formal sequences, while at the same time emphasising material aspects?*

Don't forget that Kubler calls his endeavour a history of *things*. You can certainly claim that there is an element of formalism in Kubler. But tellingly, he opens his book by taking his distance from Ernst Cassirer, whom he—problematically—sees as locating the achievements of the sciences and the arts completely in the realm of the symbolic.

My bias toward materiality has to do with my own formation and with my own background in the empirical sciences. There, even abstractions come in materialised form. Even a model is only a model if it is, in one way or the other, embodied, be it only with pencil on paper, which also has its very concrete materiality. But this also means that I have a wider conception of materiality.

What about imagination?

I describe experimental systems as exteriorised spaces of imagination.

Somehow I wouldn't want to exclude from what may simply be called "thinking" the types of surprises that you describe as resulting from experimental systems.

If something remains in the realm of dreams, it will never come to have any impact on a historical process such as the sciences or the arts. Exteriorisation is a precondition for something to become workable and interactive. Edmund

Husserl (1978) is absolutely right when he states that even the formal sciences—which to him meant mathematics—would be completely unthinkable and historically not understandable without the exteriorisation that writing has brought to this form of engaging with the world.

Which, of course, led Derrida to focus on the exteriority of writing.

The early Derrida took this point up from Husserl and put it at the centre of his thoughts about science and objectivity.

Given the exteriority of writing, in my understanding, within the graphematic space, both material and sign are co-created. Rather than—from a representational perspective—conflating the graphematic with the material, should one not better—from a graphematic perspective—focus on the complex relationship between material and sign, which representation disavows?

Of course, you can make the point that in the space of representation—let us stick with the notion of representation here for the moment—it is precisely its potential of becoming disconnected from the graphematic space that makes it fruitful.

How is ontic complexity outside the lab related to the epistemic complexity within the experimental landscape?

I think here we have to consider two different orders. Without epistemic complexity and without the establishment of an epistemic space—graphematic and representational—you wouldn't be able to say anything about ontic complexity. What we have here is retro-action. What we call ontic complexity is the product of epistemic complexity in exactly the sense that Hacking (1983, 130–46) uses the term "reality" when he says that this is a second-order concept. Only when alternative ways of representation—or, as I would say, spaces of experimentation—come into being, does reality, as something beyond, become a problem to talk about.

Could research be associated with the graphematic and science with the representational space, while maintaining that they both operate in tandem?

Why not? The sciences, as we know them today, are unthinkable without research. Nevertheless, research is not the whole science. Science, in its stabilised technical form, is embodied in many products we use in our everyday life, from cars to electronic gadgets. The education system also belongs to our scientific reality: more scientists are needed in order to go on with research. You need a transmission system where the state of the art can be given over to the next generation as it is, fixed in relatively uncontroversial form in textbooks. There is more to the epistemic universe of our societies than just research. In terms of percentage, research amounts to probably no more than some-

thing between ten and twenty percent. Certainly less than one third of the money allotted to science and education goes into research activities, properly speaking.

Are you suggesting that research takes place in a marginal space?

I would certainly not say that it is marginal; it is an integral part of the entire epistemic space.

In a Derridean sense: the margins of philosophy?

Very necessary margins.

EXPERIMENTAL HISTORY

Is the notion of "experimental system" part of your *experimental system?*

Yes, if I can take your somewhat tautological question to mean: "Does the work of the historian of science also take place in a sort of experimental system?" Eduard Dijksterhuis ([1959] 1969) argued in this direction, and his words were taken up by Georges Canguilhem (1975), who also stressed that the history of science is to be seen as the laboratory of epistemology. Working with the notion of "experimental system" in order to make sense of certain aspects of history of science has in itself an experimental character. You try out how far it takes you, what kind of phenomena you are able to cover with it and where it has—first, historically and second, narratively—its boundaries. Historically: I myself never went further back than the late eighteenth century in my historical case studies, but if it comes to early modern science—let's say sixteenth- or seventeenth-century science—it is by no means evident that the notion of "experimental system" would help. The historical range of the notion is open for debate. Narratologically: We already talked about experimental systems as being embedded in cultures of experimentation. Here we encounter the problem that time spans matter—"time" comes in many registers for someone who studies the history of science. By using "experimental systems" as your historical unit of analysis, you operate mainly in a short-term range. A case study, like the one I did on the history of protein biosynthesis research, occurs within the lifetime of one particular scientist or a group of scientists and their particular experimental system, whereas if you want to understand what characterises a century of scientific activity, you will in all probability have to choose another unit, say "experimental cultures." When it comes to covering several centuries, it may even become problematic to take "experimentation" as the centre of your focus. In *A Cultural History of Heredity* (2012), a book I recently wrote together with Staffan Müller-Wille, we took the notion/phenomenon of heredity to cover a period of about four centuries. This notion/phenomenon, of course, then has to be set and seen in its various historically changing practical contexts. So it is clear that in order to write such a long-term narrative, the

object of one's focus needs to change. Doing history of science is, in itself, a very multifaceted activity imbued with epistemic problems. It is an experimental space in itself.

It is thus important to be clear about the level at which one talks, since a notion such as "experimental system" operates at a meta-level. As a historian of science, I try to make sense of the process of scientific research in a particular time frame and to find conceptual tools in order to characterise this process. However, this does not imply that a scientist, when working, operates and thinks in the same categories and framework, even if, in this case, the notion of "experimental system" is an actor's category.

Did such meta-level reflections help you during the time you worked as a scientist in the laboratory?

I would be lying if I claimed that my philosophical reflections helped me to do good experiments. I would even be inclined to claim the contrary and suggest that one should forget about this meta-level of reflection while actively engaged in research work. In the act of knowledge-production, the connection between the base-level and the meta-level is probably less tight. This doesn't mean that there is no relevant relation between these two levels. At times, scientists also need to switch into a reflexive mode—if only when they have to write a grant proposal. Looking at how these different contexts relate to each other, we probably arrive at a complicated structure, but one that comes nearer to the actual situation.

Has the analytical unit "experimental system" run its course?

Our negotiation with the world under a knowledge perspective leads to different "ways of knowing"—to use the words of John Pickstone (2000). Once in place, they don't just disappear again. They tend to stay, but they change their relative importance over time. Experimental systems played a very minor role before the eighteenth century, if they played a role at all. They came to acquire a predominant role in the later nineteenth, which they kept throughout the whole twentieth century. Their future fate is not predetermined by this role. Indeed, what we observe today as "big science," including global consortia that involve not only hundreds but sometimes even thousands of people all over the globe, is in need of a characterisation for which the notion of experimental system is probably not enough.

If you take seriously the material with which you work, there can always come a point where you can no longer get along with the concepts you use. Then you will need to find other conceptual tools to get out of the impasse. Let us not ontologise these categories, be they "epistemic things" or "technical objects" or "experimental systems." These notions themselves are historically and narratologically situated. We should not reify them. It is important to be attentive to the resistance with which the material presents you when you approach it through these categories.

SCIENCE AND ART

Looking at science-art collaborations it seems that by and large artistic practice isn't granted access to the scientific spaces of experimentation and that it simply functions to communicate science to the public.

Yes, of course, there is this function. For example, if you look around in the Max Planck Institute for the History of Science or go to the Max Planck Institute for Molecular Genetics across the street here in Dahlem, you will see the work of artists on display that was inspired by what the researchers are doing there. An inspiration that goes the other way around is harder to imagine in such a context. Usually, these are one-way enterprises where the science involved in the cooperation remains untouched by these artistic activities.

Within a theory of experimental systems, shouldn't one expect more interaction between artistic and scientific practices on the level of research? Is there perhaps a principal problem with science-art collaborations?

No, I don't think there is a principal obstacle. Over the past several years, I have experienced a particular kind of collaboration between an artist, Hannes Rickli, and a number of biological laboratories in Switzerland, Germany, and the United States. Rickli participates in the data-stream production of these labs without following the direction that the scientists take when they process their data. He manipulates and somehow reconfigures virtually the same graphematic material that scientists use in the creation of their models. In the regular meetings between the artist, the scientists of these laboratories, and a small group of art historians and historians of science, one could see that the scientists were really affected by the artist's work. They came to learn to see what they did with their data in a new light—the traces with which they worked along trodden paths became thick again for them. However, for this to happen, one needs scientists who are receptive and don't say, "Why should I lose a day in playing around with this?" It is maybe a special situation, but what happened there is indeed something of a two-way communication between artists and scientists.

As the disciplinary boundaries lose importance, has a shared aesthetic space become possible where, beyond the processing of sense data, artistic *concerns also matter?*

We have been living with the divergence of aesthetics and epistemics for probably two hundred or three hundred years. For quite some time, the epistemic sided with truth and the aesthetic with beauty; the two realms appeared to be more and more separated from each other. However, there have been developments in the arts, at least from the late nineteenth century and over the twentieth century that no longer define themselves in terms of the beautiful. On the other hand, the relation between science and truth has also been problematised along different axes. Moreover, there is a growing awareness of the fact that aesthetic processes also carry a knowledge element along with them and

that epistemic processes have aesthetic connotations. Doing science is, after all, a way of seeing. However, I am not saying that we should try to do away with these boundaries altogether. After all, we can't jump over history. I think Jacques Derrida's attitude concerning the dichotomies of occidental philosophy in his *Grammatology* ([1976] 1997) is still valid and valuable. We can't just get rid of occidental metaphysics with its millennial tradition. Whether we like it or not, we are in it. All we can do is shift boundaries from within. We should not have the illusion that we can start with a clean slate, but we can sharpen our awareness about these boundaries and then try to rework them from within.

How does this apply if one moves from art's productive role regarding perceptions to, for example, post-conceptual art as a type of systems art that seeks to produce events outside systematic or institutional definitions?

The main thrust of any experimental system is that it is able to point beyond itself. It would be boring if it did not work according to such a tendency of immanent transcendence, as it is so nicely described by philosopher and art historian Edgar Wind in *Experiment and Metaphysics* (2001).

Returning to the issue of practice with which we started, the notion of experimental approaches to art-making seems to imply that one's hands could be put to work differently. Experimentation can be seen as a way to cleanse late-Romantic expectations of authorship from what are otherwise very similar processes of moving materials around. While the practice of handling paint, for example, may be identical, the spirit of its handling has completely changed, so that a different artistic experience may be had. Is that something one can also trace in the sciences?

It is all about the epistemic effects of these acts and activities. They don't just occur out of the blue. Just to give an example: I have the impression that an artist like Cézanne, who painted hundreds of apples in his countless later still lifes, must have been caught in a kind of experimental system. It was all about tiny changes and iterations—doing it again and again and always with a small differential gesture. I am interested in the creation of differences through such processes of iteration, be it in the sciences or in the arts. Holding these small differences against each other produces knowledge effects. The very process of iteration brings these slightly different variants of an experimental process into contact with each other. It is not the relation between a thinking mind and object on the table in front of it, the classical relation between a knowing subject and an object posed before it; the basic idea is to introduce multiplicity at the object-level itself and thus to get rid of the classical dualistic structure of epistemology. Musical variations are a wonderful example of processes of iteration. In this sense, I think, scientific and artistic activities share something in common, although their respective knowledge effects may be of a different order or a different kind. Certainly the product is of a different kind. In the case of Cézanne, these still lifes can be seen in museums, whereas in science, comparable things are usually buried in protocol books. If they happen to

mature into a real product, then it's a publication, but trying to understand the whole process from the perspective of the publication or the finished painting is probably not enough. Looking at the way these things come into being, we may see similarities between the two creative activities—although, by the way, I don't like the notion of creativity. It tends to obscure the materiality of the process, and to locate itself on the spiritual side. An artist's studio is not only an aesthetic space, it is usually also an epistemic work-space with a lot of intellectual as well as material investment, an investment that tends to disappear in the product. But for the artist, it's an integral aspect of his or her work, without which she or he probably would not be motivated to carry out that work.

Given that at various points in your scientific discourse you make reference to art, it seems as if the closer one gets to moments of epistemic emergence, the more metaphors are required that implicate the arts.

At a very general level, we can identify points of comparison within what we call—for lack of a better notion— "creative activities." In all these areas of cultural activity, people are working—let us put it very generally—at the boundaries of the unexplored, of the unknown, to narrow it down for the sciences. They have to develop strategies that allow them to reach out into an uncharted space, while lacking the means to characterise that space from the point at which they stand. Reaching out into the unexplored is something that appears to me to be a common characteristic of all these activities, although, when it comes to the description of the details, the way this happens might turn out to be very different in a scientific, as opposed to, for instance, a literary exploration. It's all about activities that are situated at the boundary between the explored and the unexplored, where the explored usually takes the form of an arsenal from which you arm yourself in your work. We are confronted with a movement that is reaching out into a space that has a horizon that we cannot see—or, as Thomas Kuhn (1992) once very aptly put it, we are being driven into it from behind. We are not being driven into this open horizon by something identifiable out there that would tell us where we would have to arrive at; rather, we are being driven by the current state of the art—as the saying goes—but we know that we don't want to be captured in and bound to the current state of the art. A similar metaphor can also be found in Kubler ([1962] 2008). As an artist, he says, you stand in the dark at the end of a mineshaft that the generation before you has driven into the ground. Your exploratory activity is based on the fact that the shaft's end doesn't tell you which direction you should take. You know the direction that has been taken before you, and now you are in a situation where you are informed by what happened so far, but unable to act according to a far-reaching anticipation. I think this is a situation that has epistemic aspects to it, questions of orientation, be it in literature, music, the visual arts, the sciences in all their variety. These activities use widely different means and operate according to widely different gestures, behaviours, and forms of realisation, and the products that come out of these activities form universes that in no way coincide with each other. We are surrounded by a multiplicity of

cultural achievements irreducible to one another; but in spite of this multiplicity, there is something that these activities have in common.

What I just called "exploratory activity" is something that situates itself in the space of *bricolage*, and this is a dangerous space. It is an unsecured space. To return to an earlier moment in our conversation, it is not something that one would wish to impose on everyday life, or on society as a whole. These spaces are thus bounded and contained as exploratory spaces. And yet, our everyday life and our societies depend on them.

Can there be rules that one should follow if one is engaging in a research process? What structure does this activity have, given that one is constantly occupied with undoing structure? Structures can become obstacles that need to be overcome, as Bachelard (2002) suggests in his reflections on what he calls the "epistemological obstacle." He says that to establish something as a scientific fact creates at the same time a feat and an obstacle that henceforth has to be overcome again. Here we have once more the dialectic between the technical and the epistemic, under yet another perspective.

Why do you think that people with an arts background have such an interest in your work?

The question is very hard to answer because I am surprised myself about the resonance beyond the bounds in which my work was conceived. I can envisage two aspects that people with a background in the arts might find attractive. One is my focus on the materiality of the research process, and the other is that the kind of historical epistemology that I favour makes scientific activity appear less hermetic than it is usually seen to be. However, I like the interest, because it drives and challenges me to try to answer questions that I would not even have asked myself. When I am sitting with somebody like you, who is asking me all these crazy and sometimes hard-to-understand questions, it forces me, first, to reflect in novel ways and from novel perspectives about what I have been doing. Second, it brings the relations between the arts and the sciences into focus, and I think that this relation is in need of much more serious attention and much more historical as well as epistemological investigation.

REFERENCES

Althusser, Louis. 1974. *Philosophie et philosophie spontanée des savants (1967)*. Paris: Maspero. Translated by Warren Montag as "Philosophy and the Spontaneous Philosophy of the Scientists (1967)," in *Philosophy and the Spontaneous Philosophy of the Scientists and Other Essays*, edited by Gregory Elliott (London: Verso, 1990).

Bachelard, Gaston. 1949. *Le rationalisme appliqué*. Paris: Presses Universitaires de France.

———. 2002. *The Formation of the Scientific Mind: A Contribution to a Psychoanalysis of Objective Knowledge*. Translated by Mary McAllester Jones. Manchester: Clinamen. First published 1938 as *La Formation de l'esprit scientifique: Contribution à une psychanalyse de la connaissance objective* (Paris: Vrin).

Beck, Ulrich. 1992. *Risk Society: Towards a New Modernity*. Translated by Mark Ritter. London: Sage. First published 1986 as *Risikogesellschaft: Auf dem Weg in eine andere Moderne* (Frankfurt am Main: Suhrkamp).

Canguilhem, Georges. 1975. *Etudes d'histoire et de philosophie des sciences*. 3rd ed. Paris: Vrin. First published 1968.

Derrida, Jacques. (1976) 1997. *Of Grammatology*. Translated by Gayatri Chakravorty Spivak. Baltimore: Johns Hopkins University Press. First published 1967 as De la grammatologie (Paris: Éditions de Minuit). This translation first published 1976 (Baltimore: Johns Hopkins University Press).

———. 1982. "Différance." In *Margins of Philosophy*, translated by Alan Bass, 1–28. Chicago: University of Chicago Press. First published 1972 as *Marges de la philosophie* (Paris: Éditions de Minuit).

Dijksterhuis, Eduard J. (1959) 1969. "The Origins of Classical Mechanics: From Aristotle to Newton." In *Critical Problems in the History of Science*, edited by Marshall Clagett, 163–84. Madison: The University of Wisconsin Press.

Fleck, Ludwik. 1979. *Genesis and Development of a Scientific Fact*. Edited by Thaddeus J. Trenn and Robert K. Merton. Translated by Fred Bradley and Thaddeus J. Trenn. Chicago: University of Chicago Press. First published 1935 as *Entstehung und Entwicklung einer wissenschaftlichen Tatsache: Einführung in die Lehre vom Denkstil und Denkkollektiv* (Basel: Benno Schwabe).

———. 1983. "Zur Krise der 'Wirklichkei.'". In *Erfahrung und Tatsache: Gesammelte Aufsätze*, edited by Lothar Schäfer and Thomas Schnelle, 46–58. Frankfurt am Main: Suhrkamp.

Geertz, Clifford. 1973. *The Interpretation of Cultures*. New York: Basic Books.

Groß, Matthias, Holger Hoffmann-Riem, and Wolfgang Krohn. 2005. *Realexperimente: Ökologische Gestaltungsprozesse in der Wissensgesellschaft*. Bielefeld: Transcript.

Hacking, Ian. 1983. *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press.

Husserl, Edmund. 1978. "The Origin of Geometry." Translated by David Carr. In *Edmund Husserl's "Origin of Geometry": An Introduction*, by Jacques Derrida, translated by John P. Leavey, Jr., 155–80. New York: Harvester. Husserl's essay first published 1939 as "Die Frage nach dem Ursprung der Geometrie als intentional-historisches Problem" (*Revue internationale de philosophie* 1 [2]). Derrida's book first published 1962 as *Edmund Husserl: L'origine de la géométrie* (Paris: Presses universitaires de France).

Krohn, Wolfgang, and Georg Krücken, eds. 1993. *Riskante Technologien: Reflexion und Regulation; Einführung in die sozialwissenschaftliche Risikoforschung*. Frankfurt am Main: Suhrkamp.

Kubler, George. (1962) 2008. *The Shape of Time: Remarks on the History of Things*. Rev Ed. New Haven, CT: Yale University Press. First published 1962.

Kuhn, Thomas S. 1992. *The Trouble with the Historical Philosophy of Science*. Robert and Maurine Rothschild Distinguished Lecture, 19 November 1991; An Occasional Publication of the Department of the History of Science. Cambridge, MA: Department of the History of Science, Harvard University.

Lacan, Jacques. 1986. *Le Séminaire de Jacques Lacan, Livre VII: L'éthique de la psychanalyse, 1959–1960*. Edited by Jacques-Alain Miller. Paris: Éditions du Seuil. Translated by Dennis Porter as *The Ethics of Psychoanalysis, 1959–1960: The Seminar of Jacques Lacan, Book VII* (London: Tavistock / Routledge, 1992).

Latour, Bruno. 1988. "Drawing Things Together." In *Representation in Scientific Practice*, edited by Michael Lynch and Steve Woolgar, 19–68. Cambridge, MA: MIT Press.

———. 1993. "Le 'pédofil' de Boa Vista—montage photo-philosophique." In *La clef de Berlin et autres leçons d'un amateur de sciences*, 171–225. Paris: La Découverte.

Lévi-Strauss, Claude. 1962. *La pensée sauvage*. Paris: Plon. Translated as *The Savage Mind* (London: Weidenfeld and Nicolson, 1966).

Mayntz, Renate, and Thomas P. Hughes, eds. 1988. *The Development of Large Technical Systems*. Frankfurt am Main: Campus.

Müller-Wille, Staffan, and Hans-Jörg Rheinberger. 2012. *A Cultural History of Heredity*. Chicago: The University of Chicago Press. First published 2009 as *Vererbung: Geschichte und Kultur eines biologischen Konzepts* (Frankfurt am Main: Fischer).

Pickstone, John V. 2000. *Ways of Knowing: A New History of Science, Technology and Medicine*. Manchester: Manchester University Press.

Popper, Karl. 1935. *Logik der Forschung*. Vienna: J. Springer. Translated as *The Logic of Scientific Discovery* (London: Hutchinson, 1959).

Reichenbach, Hans. 1938. *Experience and Prediction: An Analysis of the Foundations and the Structure of Knowledge*. Chicago: University of Chicago Press.

Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford: Stanford University Press.

———. 2010. "Über Serendipität—Forschen Und Finden." Paper presented at the Eikones Jahrestagung "Imagination: Suchen und Finden," Basel, 17–19 November 2010.

———. 2012a. "'Das Wesen der Forschung besteht im Übersteigen von Grenzen': Ein Gespräch mit Wolfert von Rahden über historische und aktuelle Grenzverläufe der Wissenschaften." *Gegenworte: Hefte für den Disput über Wissen* 27: 38–42.

———. 2012b. "Experiment, Forschung, Kunst." *Dramaturgie* 2/12: 11–14.

Wind, Edgar. 2001. *Experiment and Metaphysics: Towards a Resolution of the Cosmological Antinomies*. Translated by Cyril Edwards. Oxford: Legenda. First published 1934 as *Das Experiment und die Metaphysik: Zur Auflösung der kosmologischen Antinomien* (Tübingen: Mohr).

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Hannes Rickli studied photography and theory of design and art. He teaches as professor at the Zurich University of the Arts. Solo and group exhibitions include *Cross Over: Fotografie der Wissenschaft & Wissenschaft der Fotografie*, Fotomuseum Winterthur, 2013; *Fischen lauschen: Beginning of Data Transmission from the Arctic Sea*, Schering Stiftung Berlin, 2013; *Art with Experimental Systems*, Kunstmuseum Thun, 2011; *Videogramme*, Helmhaus Zurich, 2009; *Aggregat Chemnitz*, Galerie Weltecho, Chemnitz, 2008; *Art as Research: Figurations of Knowledge*, Villa Elisabeth, Berlin, 2008; and *Say It Isn't So: Art Trains Its Sights on the Natural Sciences—Naturwissenschaften im Visier der Kunst*, Weserburg, Museum für moderne Kunst, Bremen, 2007. Publications include "Precarious Evidence: Notes on Art and Biology in the Age of Digital Experimentation" in *Intellectual Birdhouse: Artistic Practice as Research* (London: Koenig Books, 2012), *Videograms: The Pictorial Worlds of Biological Experimentation as an Object of Art and Theory* (Zurich: Scheidegger & Spiess,

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Michael Schwab is a London-based artist and artistic researcher who investigates postconceptual uses of technology in a variety of media, including photography, drawing, print-making, and installation art. He is tutor at the Royal College of Art, London, and the Zurich University of the Arts, as well as Research Fellow at the Orpheus Institute, Ghent. He is co-initiator and editor-in-chief of *JAR, Journal for Artistic Research*. Educated in both philosophy (Hamburg University) and art (Royal College of Art, London), his research focuses on the methodologies and epistemologies of artistic research. Concentrating on experimentation and the exposition of practice as research, he has developed a conceptual approach that links artistic autonomy with academic criticality in support of what has been called the "practice turn in contemporary theory." Together with Florian Dombois, Ute Meta Bauer, and Claudia Mareis he co-edited *Intellectual Birdhouse: Artistic Practice as Research* (London: Koenig Books, 2012). *The Exposition of Artistic Research: Publishing Art in Academia*, which he is editing with Henk Borgdorff, will be published by Leiden University Press.

Stephen A. R. Scrivener studied fine art at undergraduate and master levels, the latter at the Slade School of Fine Art, University College London, where he began to use computers for art production. After the Slade, Stephen completed a PhD in computer science, later working as a lecturer and researcher in various university computer science departments before returning to the art academy. He has completed many funded research projects, produced over 175 research texts, supervised thirty-two research degree students to completion, and examined forty-five others. Stephen is the founding editor of the *International Journal of Co-Design*, published by Taylor and Francis, and an elected fellow of the Design Research Society. His inquiry into the theory and practice of artistic research, which has been reported in a series of journal papers and book chapters, proceeds from the proposition that the activities of art, design, etc., contain the activity of research, understood as that function that expands a field's potential and relevance. Stephen has recently begun to produce artworks as a means of complementing what has been, primarily, a theoretical inquiry.

Stefanie Stallschus is a senior research fellow at the Department of Art History and Historical Urban Studies at Berlin Institute of Technology. From 2005 to 2012 she was a research associate at the Academy of Media Arts Cologne. Her doctoral research on experimental films by pop artists, conducted at Freie Universität Berlin, was honoured with the Hedwig-Hintze-Frauenförderpreis. In 2008 she cofounded the media art magazine *Off Topic* and in 2010 she organised an international conference on the American art

historian George Kubler (publication forthcoming). Her research interests include intermediality in twentieth-century art, film and video art, performance art, methodologies of art history, and digital visual culture. Recent publications include "Obstinacy and Proper Time: George Kubler and the Relationship of Things to One Another" in *Vom Eigensinn der Dinge* (Bielefeld: Kerber, 2013), "Visuelle Dekonstruktionen von Gewaltdarstellungen in der Kunst der Sechziger" in *Ästhetik der Gewalt: Gewalt der Ästhetik* (Weimar: VDG, 2012), and "The Artefact and Signals from the Past: The Former National Socialist Ordensburg Vogelsang and the Need for Artistic Intervention" in *Vogelsang Intervention 2009* (Cologne: Kunsthochschule für Medien, 2011).

Neal White is an artist, the director of Office of Experiments, and associate professor at the Media School, Bournemouth University. Based in London, White's work with the Office of Experiments (established 2004) considers art within the expanded field, set in the context of its making—from scientific laboratories to urban public space or concealed spaces. Office of Experiments has undertaken international commissions in Washington, DC, and Germany and has been commissioned by the Center for Land Use Interpretation (USA) and Arts Catalyst (UK). White has collaborated with artists and writers, academics and architects, from N55 (Denmark) to John Latham (UK). He recently co-curated *Dark Places* at John Hansard Gallery, Southampton (2010), and has exhibited widely, at Apexart, New York (2010), FACT, Liverpool (2008), Henry Moore Institute, Leeds (2005), the Natural History Museum, London (2003), and Moderna Museet, Stockholm (1998). He was a founding director of Soda (1997–2002) and director of O + I from 2007–9 (formerly Artist Placement Group). His work has been funded by Arts Council England, Henry Moore Foundation, Washington DC Arts and Humanities Commission, Heritage Lottery Fund, and the Gulbenkian Foundation.

Susanne Witzgall holds a PhD in art history and is head of the cx centre of interdisciplinary studies at the Academy of Fine Arts Munich. From 2003 to 2011 she was an assistant professor at the Department for Art History at the same institution. From 1995 to 2002 she worked as a curator for the Deutsches Museum Bonn and the Deutsches Museum, Munich. Her research interests focus especially on the interfaces between art and science, art and sociology/cultural anthropology, art as research, and knowledge production. She has curated and co-curated several exhibitions in Germany and Austria, among them *Art & Brain II* (1997/98), *The Second Face* (2002, with Cornelia Kemp), *Say It Isn't So* (2007, with Peter Friese) and *(Re)Designing Nature* (2010/11, with Florian Matzner). She is the author of several books and articles on contemporary art and art and science, including *Kunst nach der Wissenschaft* (Art after science) (2003) and *New Mobility Regimes in Art and Social Sciences* (with Gerlinde Vogl and Sven Kesselring, forthcoming 2013).

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