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The Exhibition as Product and Generator of Scholarship

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The Exhibition as Product and Generator of Scholarship – An Introduction

Susanne Lehmann-Brauns, Christian Sichau, Helmuth Trischler

Some two years ago, a collaboration of various Swedish museums and academic institutions organized an international and interdisciplinary symposium. The aim was to discuss the importance of research for exhibitions and the relation between research in academia and in museums. The organizers were worried about the shrinking knowledge base of museums; they were worried that the rich possibilities offered by new media-technology – and not new insights based on research – increasingly dominated questions of communication with visitors; they were worried that traditional functions of museums, namely to collect, to care for and to research cultural artifacts, tended to lose ground. For many participants of this well attended conference, the motto for the symposium that "research generates exhibitions which in turn generate research" has become a general guideline.[1]

What started as a local and defensive undertaking, soon gained momentum. The stimulus from the European periphery has spread across Europe. We have witnessed a growing interest of political and scientific stakeholders in museums as places of research. In Germany, for example, a number of organizations took up the Swedish initiative and set up programs to foster research at museums. The Volkswagen Foundation held a large conference with the Schillerian title "Was heißt und zu welchem Ende betreibt man Forschung in Museen" (What Is, and to What End Do We Do Research at Museums, December 17 to 19, 2007). This formed the basis for its new program "Research in Museums". It is directed to encourage research at medium-sized and small museums by facilitating network building among each other and in particular with universities or research institutions. Further, it promotes international networking of large research-based museums, and it serves to sharpen the research profile of museums in the public perception.[2] In addition, the German Federal Ministry of Education and Research launched a new initiative. Within its strategic program to strengthen the Humanities it is directed at the scholarly collaboration between museums and universities. In a first round, about two dozens of collaborative projects have been funded by the Ministry. Furthermore, the Federal Cultural Foundation and the Cultural Foundation of the States jointly initiated a "Programme for the Conservation of Moveable Cultural Assets". It aims at the protection of collections that are severely threatened by deterioration. This program places great emphasis on collaborations of museums with national and international research institutes.[3] Others countries, too, have put research in museums on the agenda and have established funds for various programs. In Austria, the Federal Ministry of Science and Research offers the program "forMuse". It provides funding for a dozen of projects and intends to stimulate international research collaborations. In England, the government has opened its research programs for museums. They are now for the first time eligible to apply for national research programs. Given the dynamic of the development sketched out above, the list will surely continue to grow.

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[1] Birgit Arrhenius, Gövel Cavalli-Björkman, and Svante Lindqvist. "Preface". In *Research and Museums*. Edited by Gövel Cavalli-Björkman and Svante Lindqvist, 7-9. Stockholm: Archives of the Nobel Museum, 2008.

[2] See the program's website http://www.volkswagenstiftung.de/funding/social-and-cultural-challenges/research-in-museums.html?L=1.

[3] See the website http://www.kulturstiftung-des-bundes.de/cms/en/programme/restaurierung/KUR_Programme_for_the_Conservation_of_Moveable_Cultural_Assets.html

In a middle-term perspective, the European Union promises to develop into a prominent player in fostering research in museums. In the 5th and 6th Framework Program, the European Commission supported initiatives to make cultural heritage more accessible. The research co-operation "European Cultural Heritage Online" (ECHO) is a highly visible example for what can be achieved when European-wide funding is provided. The project was led by the Max Planck Institute for the History of Science and involved a number of research institutes, archives, libraries, and museums. The 7th Framework Program will offer extended opportunities for projects intended to increase the accessibility of museum collections for both the scholarly community and the general public.

In addition to this encouragement by funding agencies, the value of museums has increasingly been acknowledged by historians of science. They have started to take material sources more into account. The comprehensive use of material scientific objects, tools and instruments has led to a deeper understanding of past and contemporary scientific practices. Thus, a new perspective on the epistemic value of material things as protagonists of past scientific processes has emerged. This development has already been identified as the "practical turn" in the fields of history of science and social studies of science. With new focus on the material dimensions of doing research museums have become attractive places for researchers based in academia.

However, as all those working in museums know, exhibitions are shaped by a variety of different and sometimes conflicting agendas. The director of the Museum of History of Science at Oxford, Jim Bennett, has remarked succinctly, "history of science has no divine right to rule just because the objects in the museum are old".[4] Bennett reminds us that scholars and exhibition makers alike have to take into account a hidden audience of exhibitions: the various stakeholders in museums and institutions, sponsors and politicians. This is all the more important since museums have come under severe pressure – notwithstanding the above mentioned funding programs for scholarship in museums. Whereas exhibitions are booming, the very basis of exhibitions – collecting, preserving and object based research – is threatened in many museums. Curators have to take on more and more responsibilities and whether research is a relevant part of their job description is not a matter of course.[5]

Given this conflicting evidence, strategies have to be developed for the handling of our current situation. On the one hand, we can point to the many positive examples we have witnessed in recent years which managed successfully to bridge the gap between academic researchers and museum practitioners. According to Anke te Heesen, who as an experienced exhibition maker and academic historian of science has a foot in both communities, we should use the momentum of the many successful exhibitions in recent years to support museums in their struggle to live up to their own professional ideals.[6] One of the three authors of this introduction, Helmuth Trischler, has seconded that research based museums are qualified to play a key role as moderators in the dialogue between science and the public.[7] As historian of science, Susanne Lehmann-Brauns has

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[4] Jim Bennett. "Museums and the History of Science. Practitioner's Postscript." ISIS 96 (2005): 602-608.

[5] Cf. Robert Fox. "Research and Curatorship in the National Museums. A Reflexion on Threats and Opportunities." *Impact of Science on Society* 40 (1990): 263-271; and recently Robert Anderson. "To Thrive or to Survive? The State and Status of Research in Museums." *Museum Management and Curatorship* 20 (2005): 297-311.

[6] Anke te Heesen. "in medias res. Zur Bedeutung von Universitätssammlungen." *NTM* 16 (2008): 485-490.

[7] Helmuth Trischler. "Modes, Constraints and Perspectives of Research. The place of Scholarship at Museums of Science and Technology in a Knowledge-based Society". In *Research and Museums*. Edited by Gövel Cavalli-Björkman and Svante Lindqvist, 51-67. Stockholm: Archives of the Nobel Museum, 2008; ibid. "Das Forschungsmuseum – Ein Essay über die Position und Bedeutung forschungsorientierter Museen in der Wissensgesellschaft" In *Montan- und Industriegeschichte. Dokumentation und Forschung,*

demonstrated the benefits of the cross-communication of musealized objects from the collections entering spaces of scholarly activity.[8] On the other hand, there are the many problems, which museums have to face today. As the curator, museum expert and third author of this introduction Christian Sichau argues, museums are in danger to lose more and more ground within the public and the political sphere without a greater common effort and without a greater level of support.[9]

Thus, the landscape of scholarship as well as of museums has changed significantly since the Max Planck Society launched its research network "History of Scientific Objects" in 2005. The intellectual agenda of this network has been to bridge the epistemic gap between museums and academic institutes. Together the network members have started to reflect on the relevance of things. Lorraine Daston's masterful collection of essays on "things that talk" published in 2004 can be seen as a starting point of the collaboration.[10] But all these novel initiatives of the last years have not yet rendered the goal of the Max Planck Research Network in general obsolete. To the contrary: By taking a closer look at the situation, possibilities as well as problems have come to the fore.

There is, for example, the need to reflect on the intimate and at the same time delicate relationship between research activities and the making of an exhibition. Within the academic world exhibitions have been more and more recognized as an important strategy to communicate with the wider public, a public which could never be reached by scholarly books or articles alone. However, research in museums is, as the well-known historian of science and former director of the British Museum, Robert Anderson, has emphasized, "of a remarkably disparate nature".[11] Thus, academia and museums have not met on an equal footing; instead the different positions have given rise to disputes and conflicts on fundamental question like the nature of research and the nature of exhibitions. We all can agree on the general guideline that research generates exhibitions, which in turn generate research that we have cited earlier in this introduction. And we all can agree on the conceptual formula, that there can be no exhibition without scholarship. Object based studies as well as explorations of the cultural contexts of objects are prerequisites for the intelligible showing. But as soon as we start to define in more detail what these general statements might mean the need for a dialogue becomes obvious. For example, there still remains a tension between the two poles from "context without objects" to "objects without context". It has to be analyzed and reflected time and time again where research is placed between these extremes and how we can achieve and communicate in an exhibition a better relation between objects and context.[12]

Thus, we are confronted with a number of open questions, which have served the authors of this volume as guiding questions. If exhibitions do more than merely visualize the results of

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Industriearchäologie und Museum. Festschrift für Rainer Slotta zum 60. Geburtstag. Edited by Stefan Brüggerhoff, Michael Farrenkopf and Wilhelm Geerlings, 587-604. Paderborn: Schöningh, 2006.

[8] Gianenrico Bernasconi, Anna Maerker, Susanne Pickert. *Objects in transition*. Catalogue. Berlin: MPIWG, 2007.

[9] Christian Sichau. "Einstein, interaktiv und zum Anfassen. Oder: die drohende Auflösung des Museums?" *NTM* 17 (2009): 85-92.

[10] Lorraine Daston, ed. *Things That Talk. Object Lessons from Art and Science*. New York: Zone Books, 2004.

[11] Robert Anderson. "Research in and Out of Museums: Do Minds Meet?" In *Research and Museums*. Edited by Gövel Cavalli-Björkman and Svante Lindqvist, 11-25, 11. Stockholm: Archives of the Nobel Museum, 2008.

[12] From a slightly different angle Peter Galison has recently framed this tension between object and context as one the primary problems of the field; see Peter Galison. "Ten Problems in History and Philosophy of Science." *ISIS* 99 (2008): 111-124, 112-113.

research, and if they have the potential of stimulating scholarship and generating knowledge by posing new research questions: How can researchers take advantage of this opportunity? If spatial arrangements form a core part of exhibitions: How can scholarly arguments be translated into such spatial arrangements? If exhibitions are based on objects put on display: What exactly is their role for the argument presented? Recent history of science and technology has intensively interrogated the epistemic quality of these material sources of research. Yet, how do the objects unfold their properties in being staged for exhibition purposes? If exhibitions, at least many of them, have a limited lifespan: How can the arguments put forward be kept for future reading and citing? Further, unlike for printed texts, the traditional publication media of scholarship, common standards of terminology and argumentation for exhibitions have yet to emerge. How might the results of the scholarly examination of an exhibition look like?

The articles of this volume arose from the conference "The Exhibition as Product and Generator of Scholarship" which was held on November 27-28, 2008, at the Deutsches Museum in Munich. The conference aimed at bringing together exhibition makers, museum experts, designers, artists, experts in cultural studies and historians of science and technology to engage in a discussion about their experiences and expectations regarding the exhibition as product and generator of scholarship. The editors are grateful that speakers were willing to revise their presentations after the conference and to contribute to this volume. Our specific thanks go to Hannah Lotte Lund, the coordinator of the Max Planck Research Network "History of Scientific Objects", who took the burden to organize the copy-editing of the manuscripts. Without all her energy, serendipity and perseverance this volume would have taken much longer or it would have never been realized.

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KUR – Programme for the Conservation of Moveable Cultural Assets,

http://www.kulturstiftung-des-bundes.de/cms/en/programme/restaurierung/ KUR_Programme_for_the_Conservation_of_Moveable_Cultural_Assets.html (accessed March 16, 2010)

Making Visible. Visualization in the Sciences – and in Exhibitions?

Hans-Jörg Rheinberger

The following reflections on procedures of making visible in the sciences derive from a basic consideration of the constitution of the modern sciences. It is my contention that this consideration shall help in understanding how visualization is situated and embedded in the sciences and consequently, how it can be addressed and treated as an epistemic problem. It is probably not too far-fetched to postulate that making visible something that does not manifest itself directly and therefore is not immediately evident – that is, does not lie before our eyes – is the foundation and at the same time the foundational gesture of the modern sciences. Thereby, the procedures of visualization are always already connected with various forms of intervention into that which is to be represented and of manipulation of its parts. It is exactly for this reason that such a tight connection has existed among knowledge, forms of knowing, and technology throughout the history of modern scientific knowledge production. One could even speak, in this context, of a technological constitution of natural scientific knowledge production. That is to say, there resides, in the innermost of the scientific forms of knowledge acquisition, a technological momentum. It manifests itself, insofar as it is the product of an instrumental intervention, as a visible trace that is left by this very intervention.

It is this concept of trace, or primary graphism, that we can take here as a starting point.[1] The trace is a form of manifestation that has not yet become either writing or picture in their traditional forms. The trace precedes both of them. And it is from this precedent, this primary fact, that we can determine what goes on epistemically and what is at stake in the material acts of transformation of the experiment. This has been and continues to be the bottom line of the experimental systems perspective. This means, however, that reflection on the technical constitution of these trace-generating knowledge environments is essential. And it is exactly this mediation, and with it the attention to what goes on *between* the knower and the known, the knowing subject and the object of knowledge – and thus, the variegated forms of instrument-based experimentation – that never was the focus of the classical, traditional theory of knowledge. Goethe was one of the few who, already at the end of the eighteenth century and in all possible clarity, pointed to this middle space.[2] We can also refer critically to the general perception that scientific practitioners have of their field, in which this middle space has never played a central role. Scientists always tend to let it vanish behind their results, in the purported transparency of the gaze on the objects themselves.

I shall not proceed here with a particular definition of what a trace is meant to be. Nor will I discuss the issue of what it means to be an image. Instead, I would like to review, through examples, a number of procedures of visualization. First, there are what I would like to call procedures of compression and of dilatation – we can also bring these together under the notion of activities of configuration. Second, there are procedures of what can conveniently be called enhancement. And finally, there are procedures of schematization. This list is certainly not exhaustive, but with it, at least something like a first step is made toward a typology of scientific visualization.

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[1] Cf. Rheinberger, Hans-Jörg, "Spurenlesen im Experimentalsystem," in S*pur. Spurenlesen als Orientierungstechnik und Wissenskunst*, ed. Sybille Krämer, Werner Kogge, and Gernot Grube (Frankfurt/M.: Suhrkamp, 2007), 293-308; as well as the other papers assembled in this volume.

[2] Goethe, Johann Wolfgang von, "Der Versuch als Vermittler von Objekt und Subjekt," in *Die Schriften zur Naturwissenschaft. Erste Abteilung: Texte*. Vol. 8, ed. Dorothea Kuhn (Weimar: Hermann Böhlaus Nachfolger, 1962), 305-315.

All the examples of forms of making visible that I will now describe are taken from the context of four technologies of experimentation that were essential for the development of molecular biology around the middle of the twentieth century and that were mostly used in combination with each other. There is, first, the use of radioactive isotopes for the visualization of metabolic processes as well as the structures of tissues, cells, and macromolecules. The principle of this technology of making visible consists of incorporating unstable isotopes of atoms such as carbon, hydrogen, or phosphorus into bio-molecules and registering the isotopes' decay with appropriate measuring instruments. Second, it was the technology of ultracentrifugation that allowed for the isolation and differential representation of various macromolecular cellular components. Third, technologies of chromatography allowed the separation of bio-molecules that could be refined down to atomic resolution. And finally, fourth, there was the technology of electron microscopy with which cellular ultra-structures could be visualized. I should perhaps also mention that the examples here are all taken from the historical record of papers and represent observations and findings that, at the time of their publication, were all new and essentially dependent on the technology with which they came to be visualized.

Compression and Dilatation

Whether one deals with the experimental visualization of biological structures or of biological functions, either compression or dilatation is always involved, in space or in time. We could possibly even claim that one major mode of scientific experimentation essentially consists of envisaging and generating such contractions and expansions, such slow-downs and speed-ups in order to bring the investigated phenomena into the realm of the visible. What is too small has to be blown up, what is too big has to be condensed. What is too quick has to be decelerated, and what is too slow has to be accelerated in order to become visible.

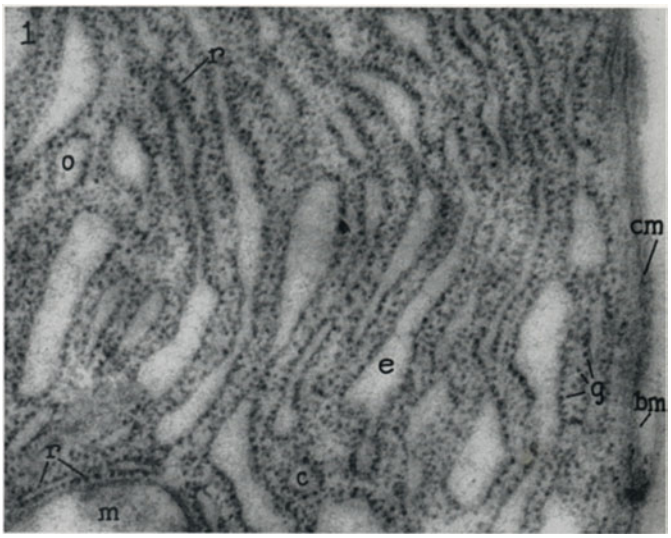

Figure 1: Electron micrography of a cytoplasmic section of a rat pancreatic cell. *cm*: cell membrane; *e, o, c*: elongated, oval and circular profiles of the endoplasmic reticulum. Magnification 73,000x.
Palade, George E., »A small particulate component of the cytoplasm«, Fig. 1, in: *Journal of Biophysical and Biochemical Cytology* 1, 1955, pp. 59-68.

One of the typical forms of a *dilatation of a structural given* is optical magnification, here an electron optical magnification. Figure 1 shows the cellular plasma of the pancreas cells of a rat. George Palade published this thin cut through a cell with a magnification of 73,000-fold in 1955. Palade counts as the discoverer of the cytoplasmic structures that came to be known under the term "endoplasmic reticulum."[3] This membrane system had been completely unknown to histology, which until then had been based on light microscopy. One sees that the membranes of this cellular structure are associated with small, electron-dense particles, the so-called microsomes. They were, at the time, believed to be related to the cellular production of proteins.[4]

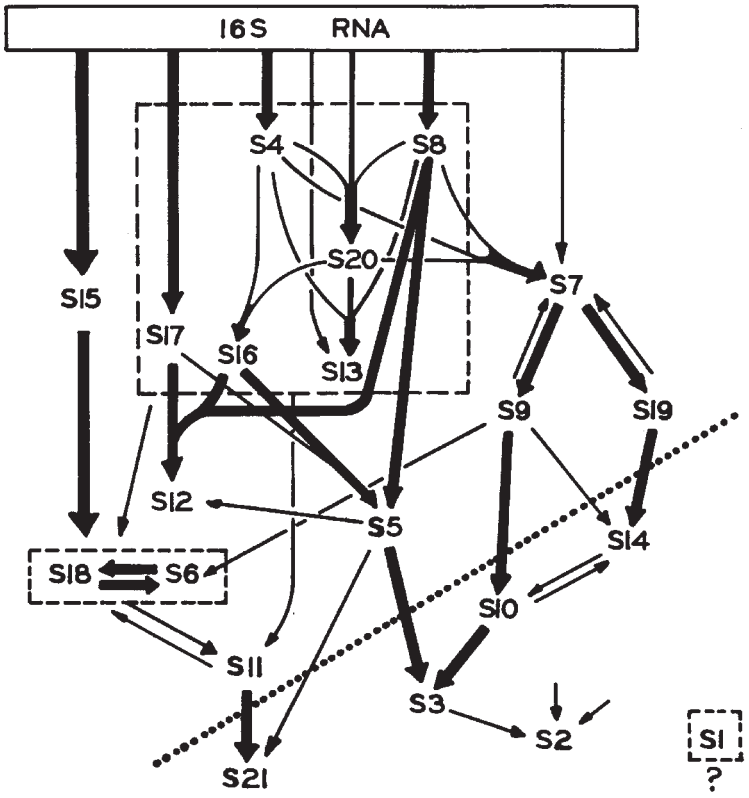

Figure 2: Assembly map of the small ribosomal subunit of *Escherichia coli*. The arrows between the proteins represent the different influences of one protein on the binding of another. Nomura, Masayasu und William A. Held, »Reconstitution of ribosomes: studies of ribosome structure, function and assembly«, Fig. 1, in: *Ribosomes*, ed. by Masayasu Nomura, Alfred Tissières und Pierre Lengyel, New York: Cold Spring Harbor 1974, pp. 193-223.

One of the typical forms of a *compression of structural data* is the map. We should think here not only of geographical maps, the classical example; other structures, even molecular ones, are accessible to mapping. The example shown here (Fig. 2) is the assembly map of a cellular organelle, the small subunit of a bacterial ribosome. It shows at one glance the successive binding events through which assembly proceeds – at least in the test tube. The map thus represents not only

[3] Palade, George E., "A Small Particulate Component of the Cytoplasm," *Journal of Biophysical and Biochemical Cytology* 1 (1955): 59-68.

[4] A historical survey is given in Rheinberger, Hans-Jörg, "A History of Protein Synthesis and Ribosome Research," in *Protein Synthesis and Ribosome Structure: Translating the Genome*, ed. Knud H. Nierhaus and Daniel N. Wilson (Weinheim: Wiley-VDH Verlag, 2004), 1-51.

structural relations between the components, but also a temporal dynamics. It was Masayasu Nomura who had succeeded at the beginning of the 1970s in disassembling this cellular organelle into its constituents and reconstituting them again in the test tube into functional particles.[5] At the same time, he determined, through countless binding assays, which of the 21 proteins involved became associated with which neighbors in the process. These assays themselves were in turn based on ultracentrifugation and chromatography.

The typical form of *compression – or of dilatation for that matter – of process data* is the curve. In a curve, whole series of measurements of a particular parameter can be brought into a synopsis. In this way, patterns can be recognized, be it of the distribution or the concentration of a substance in the space of a cell or of the body, be it of temporal trends or developments of a periodically measured parameter. Beyond a certain level of complexity, such patterns could never be read off the data tables corresponding to these curves.

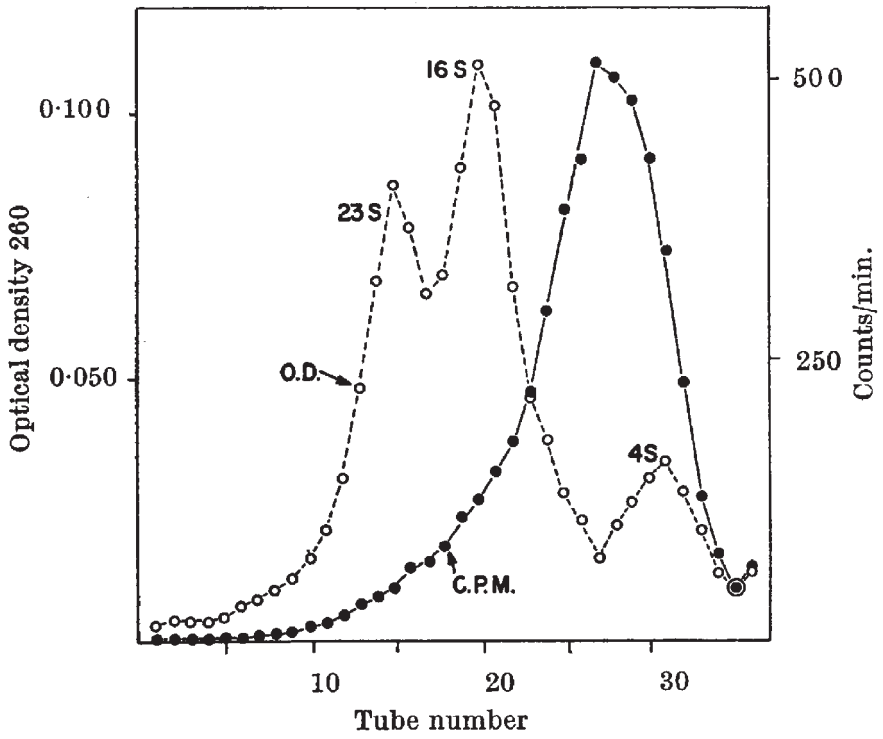

Figure 3: Sedimentation of unstable RNA of *Escherichia coli* pulse-labeled with radioactive uracil. The RNA was centrifuged through a sucrose gradient for 10 hours at 25,000 rpm and then fractionated. O.D.: optical density; 23S: RNA of the large ribosomal subunit; 16S: RNA of the small ribosomal subunit; 4S: transfer RNA; C.P.M: counts per minute.
Gros, François, H. Hiatt, Walter Gilbert, Chuck G. Kurland, R. W. Risebrough und James D. Watson, »Unstable ribonucleic acid revealed by pulse labelling of *E. coli*«, Fig. 8, in: *Nature* 190, 1961, pp. 581-585.

Figure 3 shows a comparatively simple example of such a curve. Yet on closer inspection, it nevertheless reveals a considerable complexity resulting from the interplay between the technology of radioactively labeling bacterial cells and the centrifugation of their contents through a sucrose

[5] Nomura, Masayasu, and W. A. Held, "Reconstitution of Ribosomes: Studies of Ribosome Structure, Function and Assembly," in *Ribosomes*, ed. Masayasu Nomura, Alfred Tissières, and Pierre Lengyel (Cold Spring Harbor: New York, 1974), 193-223.

gradient with subsequent fractionation into dozens of distinct fractions. With this experiment at the beginning of the 1960s, François Gros and his colleagues in Jim Watson's laboratory at Harvard were able to show that in the bacterial cell there exists a ribonucleic acid that had not been known before and that soon became prominent and found its way into the textbooks under the term "messenger RNA."[6] The curve with the white circles represents the stable forms of ribonucleic acid in the cell: the ribosomal RNA (designated 23S and 16S) and the transfer RNA (designated 4S). The curve with the black circles that is superposed on it shows a radioactive peak exactly where the optical density measurement has a valley. This suggests the conclusion that the 'new' RNA was synthesized quickly at very low concentrations and that quickly decayed again. It was labeled by means of a radioactive pulse that did not reach the stable RNA molecules.

The example shows in a rather elementary form not only the compact ordering of data in curves, but also the power and knowledge-generating function of synopsis, in this case through the superposition of two curves with different, but relatable measured data. In this way, a space of representation is generated in which data can be configured into patterns that in turn can give rise to new experiments and thus to reconfigurations of these patterns. In this sense, images themselves come to function, as it were, as instruments. They are turned into integral and productive elements of experimental cycles.

Enhancement

A second general procedure of making visible consists of *enhancing*. Here structures or processes are visualized by the application of contrasts, by staining, by stiffening at times, in short, by the super-elevation of existing forms. In the procedure, the dye or the contrasting substance becomes itself a part of that which is represented. This can of course alter the contours of the structure and has to be handled with care. The introduction of enhancing procedures into the research process therefore must obey a recursion principle.

We have already encountered one form of enhancement characteristic of molecular biology of the past half century: radioactive labeling. One of its advantages is that the radioactive isotopes do not differ in their chemical behavior from their stable variants and therefore do not alter – in the concentrations normally used – the metabolic processes that they are supposed to elucidate. Stable atomic components of bio-molecules are thus exchanged with radioactive isotopes that radiate upon decay, and the radiation can be visualized by pressing a photosensitive plate against the sample.

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[6] Gros, François, Howard Hiatt, Walter Gilbert, Chuck G. Kurland, W. Risebrough, and James D. Watson, "Unstable Ribonucleic Acid Revealed by Pulse Labelling of *E. coli*," *Nature* 190 (1961): 581-585.

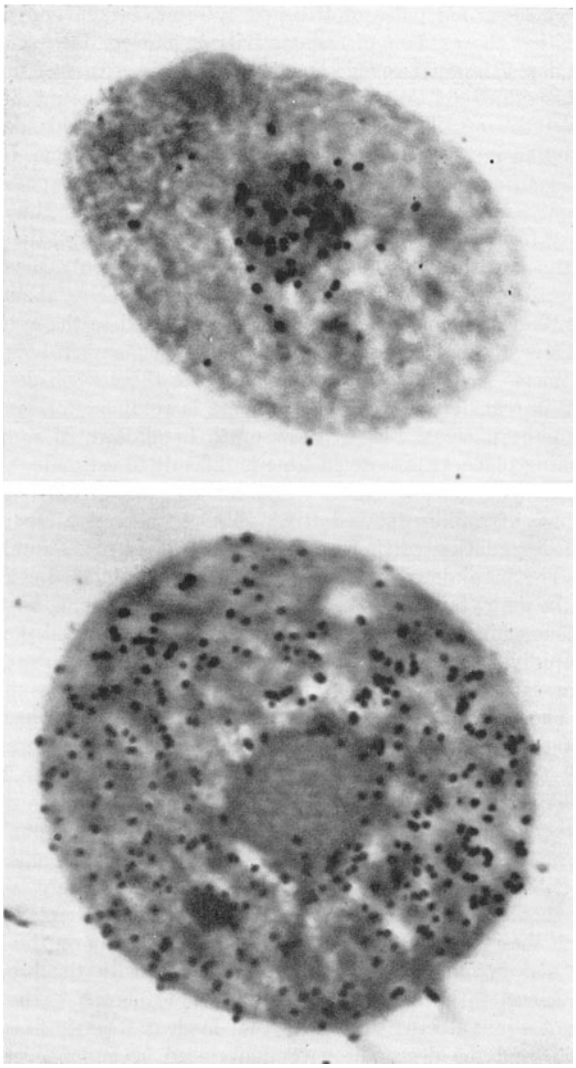

Figure 4: a) Autoradiogram of a cell (*Tetrahymena*), exposed for 15 minutes to tritium-labeled cytidine. The photography represents a thin cut of the cell exposed to a photographic plate that was subsequently developed. b) Autoradiogram of a comparable cell, exposed for 12 minutes to tritium-labeled cytidine and then incubated for another 88 minutes in the presence of unlabeled cytidine.
Prescott, David M., »Cellular sites of RNA synthesis progress«, Fig. 1, in: *Progress in Nucleic Acid Research and Molecular Biology*, Volume 3, ed. by J. N. Davidson und Waldo Cohn, New York and London: Academic Press 1964, pp. 33-57. Copyright permission: Elsevier.

Figure 4 shows the autoradiogram – sometimes also called radioautogram – of a *Tetrahymena*, a free-living unicellular ciliate, that has been labeled *in situ*.[7] The cell on the upper part of the image was exposed for 15 minutes to cytidine, a radioactive building block of ribonucleic acid. The locus of the uptake is concentrated in the nucleus, as the dark spots of the representation show. On the lower part, we see a cell that, after a short pulse-label with radioactive cytidine, was further incubated for an hour and a half in the presence of unlabeled cytidine. Now, as can be seen, the radioactivity incorporated into the ribonucleic acid has become distributed over the whole cell. The newly synthesized RNA has thus traveled from the nucleus into the cytoplasm. The juxtaposition of these two cellular states allows a neat and visual differentiation between the locus

[7] Prescott, David M., "Cellular Sites of RNA," *Progress in Nucleic Acids Research* 3 (1964): 33-57.

of the synthesis of RNA – at the DNA of the chromosomes in the nucleus – and the locus of its action – on the ribosomes in the cytoplasm. Autoradiograms are exemplary forms of enhancement.

Intensifying contrast and staining also play a role in many forms of specimen preparation in light microscopy as well as electron microscopy. Histology as it developed over the second half of the nineteenth century would have been impossible without these procedures. Electron-microscopic representations, as became possible around the middle of the twentieth century, in particular of subcellular membranes, organelles, and macromolecular assemblies, are usually in need of contrast application through the addition of heavy-metal salts, which then become selectively bound to these structures and reinforce their electron diffraction capacity.

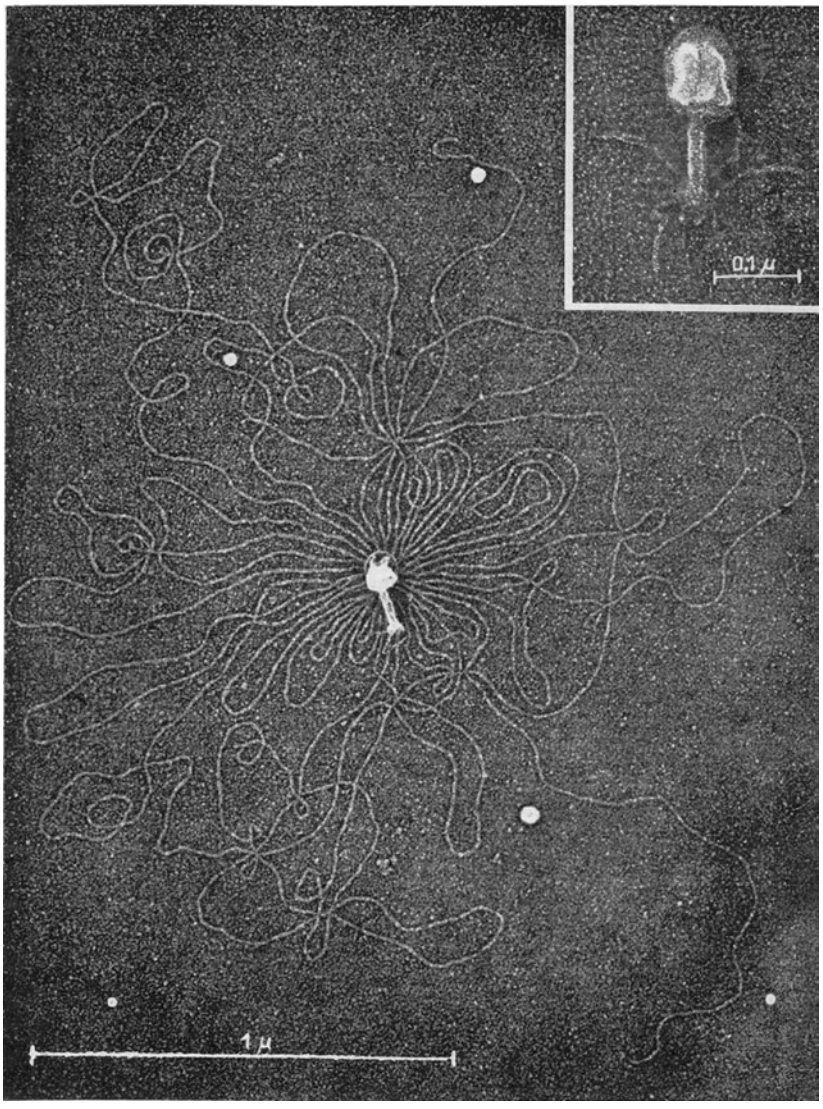

Figure 5: Electron micrograph of the DNA of phage T2. Magnification 100,000x.
Kleinschmidt, Albrecht K., Dimitrij Lang, Diether Jachters und Rudolf K. Zahn, »Darstellung und Längenmessung des gesamten Desoxyribonucleinsäure-Inhaltes von T_2-Bakteriophagen«, Fig. 1, in: *Biochimica et Biophysica Acta. Specialized Section on Nucleic Acids and Related Subjects*, Vol. 61, Nr. 6, Amsterdam: Elsevier Publishing Company 1962, pp. 857-864.

In Fig. 5 we see the DNA content of a burst phage head in the form of coils – the suggestive visualization of DNA as a long, thread-like molecule.[8] Today, labeling of macromolecules with fluorescent dyes allows for the visualization of different cellular components at the same time and does so not only *in situ*, but also enables the visualization of dynamic processes in living cells by the use of video registration procedures.

In microscopy, contrast and enhancement go along with a corresponding dilatation. In the procedure of two-dimensional chromatography, the staining of molecular components is preceded by a separation and reordering of these components. The example here given (Fig. 6) involves the representation of the protein components of a ribosome of *Escherichia coli*, the little protein synthesis machine of the bacterium. This organelle, whose small subunit we encountered in discussing the procedure of mapping, consists of more than 50 protein components in addition to its three kinds of RNA. To be precise: The demonstration of this proposed structure only became possible through the use of the chromatographic procedure in question.

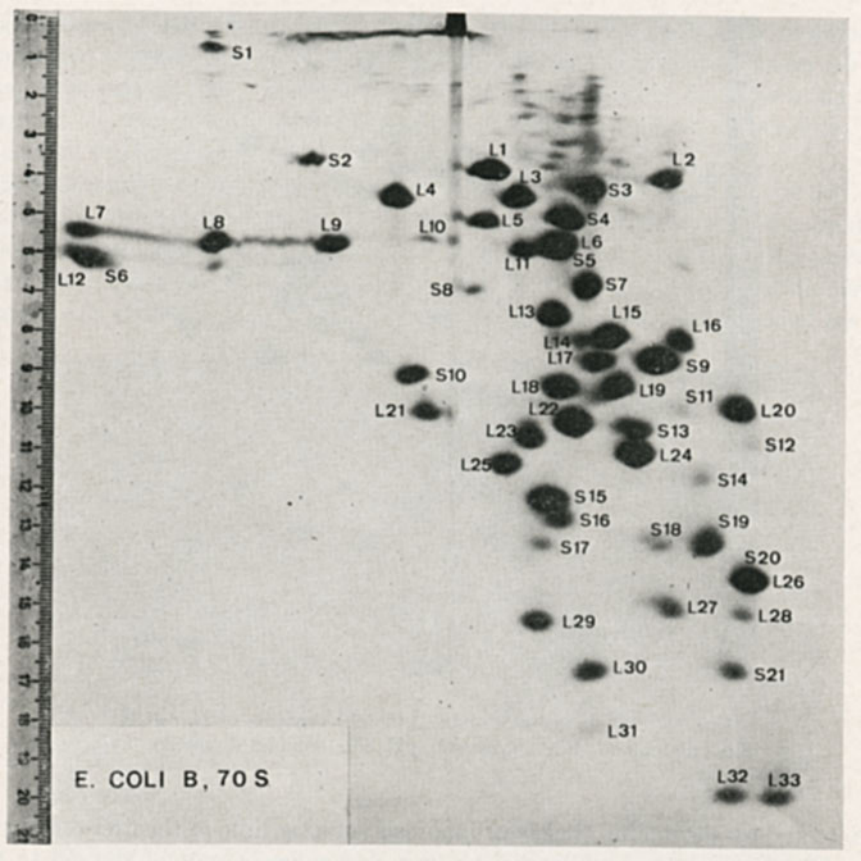

Figure 6: Two-dimensional electrophoretogram of the proteins of the *E. coli* ribosome. First dimension: 4% acrylamide, pH 8.6; second dimension: 18% acrylamide, pH 4.6.
Kaltschmidt, Eberhard and Heinz Günter Wittmann, »Ribosomal proteins. XII. Number of proteins in small and large ribosomal subunits of *Escherichia coli* as determined by two-dimensional gel electrophoresis«, Fig. 4, in: *Proceedings of the National Academy of Sciences of the United States of America* 67, 1970, pp. 1276-1282.

[8] Kleinschmidt, A. K. et al., "Darstellung und Längenmessung des gesamten Desoxyribonucleinsäure-Inhaltes von T_2-Bakteriophagen," *Biochimica et Biophyisca Acta* 61 (1962): 857-864.

Here, the proteins are separated along a first dimension according to their electrical charge and along a second dimension according to their molecular weight. Subsequently, the components can be stained with methylene blue and thus made visible on the chromatographic plate. They have become reordered in the two-dimensional space of a gel consisting of polyacrylamide. This reconfiguration has nothing to do with their native three-dimensional configuration within the organelle. In order to make this native configuration visible, still other procedures are needed, one of which we have already seen when looking at the assembly map of the small ribosomal subunit (Fig. 2). With the two-dimensional chromatographic representation, however, other essential characteristics such as the number of components involved and their size distribution can be understood. And once established, the very same procedure can serve as a standard tool for identification and as a control for the purification of particular components in further experiments.

As I have shown elsewhere in more detail,[9] the procedure of enhancement leads, as a rule, to a class of epistemic objects that can be subsumed under the concept of "preparation" - *Präparat*. Preparations are particularly widespread in the life sciences, but also in pharmacy, chemistry, and physics, and they can take widely different forms according to the technologies that are invested in them and from which they result. Anatomical and physiological preparations, based on the scalpel and on procedures of conservation, belonged to the core of animal research and human pathology beginning in the eighteenth century. With their herbaria, botanists developed their own form of dried preparations. And with glass slides, light microscopy, in particular since the second half of the nineteenth century, has created a whole new universe of micro-objects made durable. These objects have come to play widely different roles in histology, pathology, embryology, taxonomy and systematics, but also in geology and in the material sciences, that is, in widely different research contexts.[10]

Biochemistry and molecular biology of the twentieth century have brought forth their own analytical preparations, of which the gel-electrophoretic chromatogram just shown is an example. As mentioned, chromatograms bring their research object into an analytical reconfiguration that would be completely counter-indicated, for instance, in a microscopical preparation. Which means that each of these forms of preparation follows its own representational logic that has to be explored in scientific practice and whose historical realizations have to be studied in their own right. Two things, however, are characteristic of all preparations as visual forms of objects of knowledge. On the one hand, they participate, in one form or another, in the very materiality of the object under investigation. They *are* the research objects, insofar as they are not only brought into a measurable form, but also into a visible, heightened form, thus into *ecstasis*, if you like. On the other hand, they are developed in close resonance with particular instruments. They can be seen as specific responses to the analytical powers of these instruments and thus take shape at the intersection between research object and instrument.[11] They are, in a way, solidified in-betweens, objects that owe their existence to the medial spaces created by the instrument-driven experiment. And they come and go with the technology to which they are tied.

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[9] Rheinberger, Hans-Jörg, *Epistemologie des Konkreten. Studien zur Geschichte der modernen Biologie* (Frankfurt/M.: Suhrkamp, 2006), Chapter 12, Preparations, 336-349.

[10] Löwy, Ilana, Microscopic Slides: Reassessing a Neglected Historical Resource. Manuscript, 2007. See also http://scientificobjects.mpiwg-berlin.mpg.de/scientificobjectsPublic/index/Projects/Microscope-Slides.html.

[11] Cf. Rheinberger, *Epistemologie des Konkreten*, Chapter 11, 313-335.

Schematization

There is a third general procedure of visualization that plays a particular role in the representation of complex biological processes and that has, in the course of the twentieth century in particular, created its own iconology: the schematization of mechanisms. It appears as if the iconic language of schematization came into existence in parallel with the development of molecular biology. It is therefore not by chance that it found its first paradigmatic expression in James Watson's *Molecular Biology of the Gene*, whose first edition was published in 1965.[12] Until well into the 1950s, the formulaic language of biochemistry was still dominating nascent molecular biology. In the second half of the twentieth century, the new form of schematization not only made its way into the textbooks – where today it governs the representation of molecular units and their actions as nano-machines – but also into the research literature.

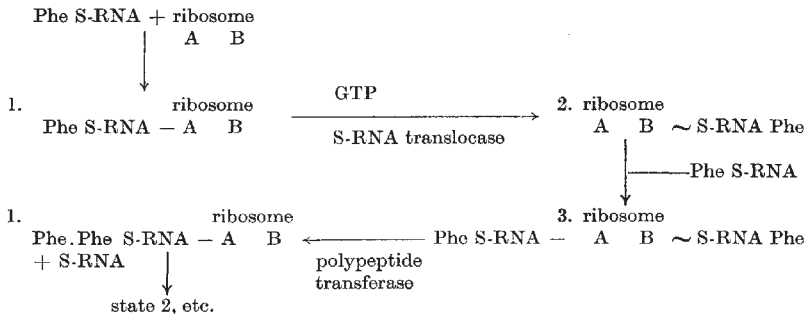

Figure 7: Model of the ribosomal elongation cycle on the basis of the puromycin reaction.
Traut, Robert R. und Robert E. Monro, »The puromycin reaction and its relation to protein synthesis«, in: *Journal of Molecular Biology* 10, 1964, pp. 63-72.

The transition from the chemical language of formulae to the image regime of schematization is exemplified in Fig. 7. It is a representation of the synthetic reaction that serves as the basis for the fabrication of proteins in the cell. Robert Traut and Robert Monro analyzed this reaction with the help of the antibiotic puromycin, which brings the reaction to a halt, and they found that transfer RNA present on the ribosome of a bacterial cell can be bound in two states, one in which it reacts with the antibiotic, and another in which it does not.[13] As one can see, this representation is still formulaic to a certain extent, although it no longer uses chemical formulae, but rather linguistic expressions for the molecular entities that characterize the process in its successive states.

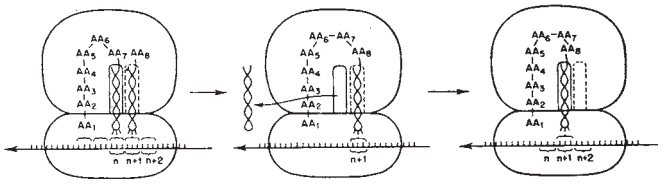

Figure 8: Model of the ribosomal elongation cycle on the basis of two binding sites for transfer RNA.
Watson, James D., »The synthesis of proteins upon ribosomes«, Fig. 20, in: *Bulletin de la Société de Chimie Biologique* 46, 1964, pp. 1399-1425.

[12] Watson, James D, *Molecular Biology of the Gene* (New York and Amsterdam: W. A. Benjamin, 1965).

[13] Traut, Robert R., and Robert E. Monro, "The Puromycin Reaction and its Relation to Protein Synthesis," *Journal of Molecular Biology* 10 (1964): 63-72.

Figure 8 shows James Watson's attempt, from the same year, 1964, to visualize the process completely as a schematic image.[14] The messenger RNA with its nucleotides is depicted as a thread that runs through an oval. The oval represents the small ribosomal subunit, on top of which sits the large subunit. The two subunits are not further differentiated. But the way in which the transfer RNA is positioned in this complex of messenger RNA and ribosomal subunits makes it clear that the recognition process between the anticodon of the amino acid-carrying transfer RNA and the codon of the messenger RNA is located in the small subunit. Meanwhile, the correct positioning of the two transfer RNAs, one of which carries the nascent protein thread, is guided by the large subunit. In addition, arrows indicate the relative molecular movement of the ribosomal complex and the messenger RNA. Although the succession of molecular states is displayed linearly, one quickly grasps that a repeating cycle is involved, in which the complex, after having reached its third state, returns to the first.

All in all, and in contrast to Traut and Monro's representation, Watson's conveys a far more intuitive, synthetic and synoptic understanding of a complex molecular mechanism. And most importantly, it represents the process in a form that allows one to ask additional questions and that suggests further experiments on the mechanism in question, and it is a form into which further experimental findings may become integrated. It expresses a certain kind of thinking in images on the molecular level that is not only easily retained, because it resembles and makes use of the forms in which mechanical processes in everyday life present themselves, but that also lends itself to playing a productive role in further experimentation.

This form of representation has accompanied protein synthesis research up to the present. Figure 9 shows a representation of the so-called elongation cycle, the prolongation of the peptide chain of a protein by one building block, from a textbook of today.[15] As can be seen, the representation has become much richer in detail and now is also explicitly cyclical. It has undergone many modifications in the course of the past forty years. Among other things, a new binding site for transfer RNA has been added, which has been a focus of research in this area for the last twenty-five years.[16]

The visualization mode of enhancement is closely tied to a particular class of epistemic objects, the preparations. The visualization mode of schematizing mechanisms in turn is tied to another class of epistemic objects we call models. Schemes such as the ribosomal elongation cycle shown here represent models of molecular processes and mechanisms. In contrast to preparations, models are visualizations that take shape in another medium. In the case of models, the research objects do not enter into the representation in material form, wholly or partially. The medium in which the model takes shape and moves can be, as in our case, a mere graphical imagining on paper. As such, it has a more abstract character. But it can also take the form of a materially constructed mechanical model, such as the one built, for instance, by Alexander Spirin in the early phase of ribosome research (Fig. 10).[17] This model has a more concrete character. It is widely known that modeling with wire and cardboard played a decisive role in the elucidation of the DNA structure

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[14] Watson, James D., "The Synthesis of Proteins upon Ribosomes," *Bulletin de la société de chimie biologique* 46 (1964): 1399-1425.

[15] Nierhaus and Wilson, *Protein Synthesis and Ribosome Structure.*

[16] Rheinberger, Hans-Jörg, "The Function of the Translating Ribosome: Allosteric Three-Site Model of Elongation," *Biochimie* 73 (1991): 1067-1088; Nierhaus, Knud H., "The Elongation Cycle," in Nierhaus and Wilson, *Protein Synthesis and Ribosome Structure,* 323-366.

[17] Spirin, Alexander S., "A Model of the Functioning Ribosome: Locking and Unlocking of the Ribosome Subparticles," *The Mechanism of Protein Synthesis. Cold Spring Harbor Symposia on Quantitative Biology* 34 (New York: Cold Spring Harbor Laboratory 1969): 197-207.

by Francis Crick and James Watson as well as the elucidation of the three-dimensional structure of hemoglobin by Max Perutz and John Kendrew in Cambridge in the 1950s.[18]

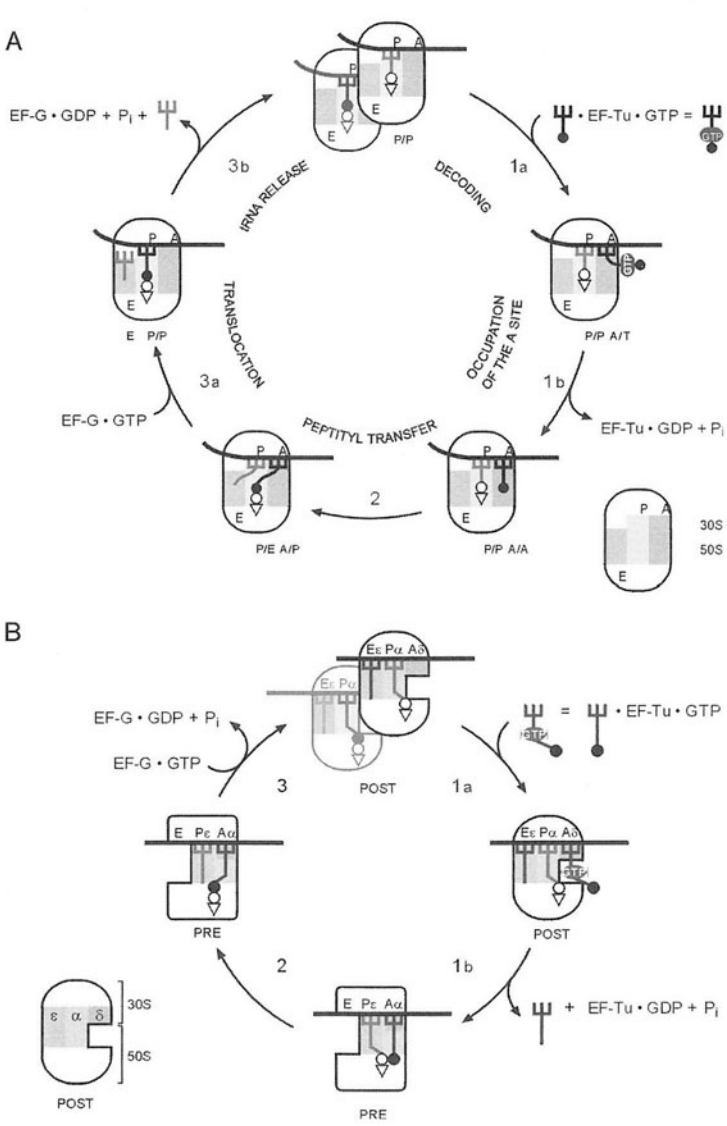

Figure 9: Models of the ribosomal elongation cycle. (A) Hybrid-site model, (B) ∝-ε three-site model.
Nierhaus, Knud H., »The elongation cycle«, Fig. 8-2, in: *Protein Synthesis and Ribosome Structure. Translating the Genome*, ed. by Knud H. Nierhaus and Daniel N. Wilson, Weinheim: Wiley-VCH Verlag 2004, pp. 323-366. Copyright permission: Wiley-VCH Verlag GmbH & Co. KGaA.

[18] Watson, James D., *The Double Helix* (London: Weidenfeld and Nicolson, 1968); Chadarevian, Soraya de, *Designs for Life. Molecular Biology after World War II* (Cambridge: Cambridge University Press, 2002).

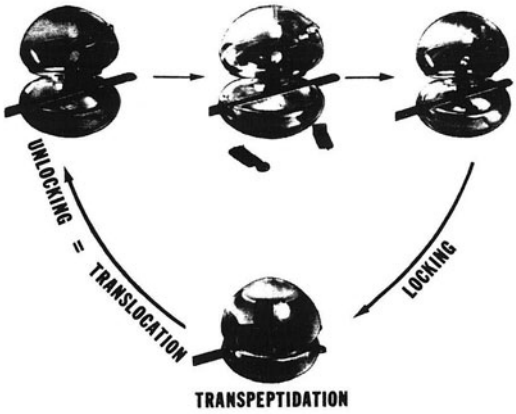

FIGURE 4. A general scheme of the working cycle of ribosome presented in terms of the locking-unlocking model.

Figure 10: Mechanical model of the working cycle of the ribosome in the form of a locking and unlocking mechanism.
Spirin, Alexander S., »A model of the functioning ribosome: locking and unlocking of the ribosome subparticles«, Fig. 4, in: *The Mechanism of Protein Synthesis. Cold Spring Harbor Symposia on Quantitative Biology*, Volume XXIV, Cold Spring Harbor, New York: Cold Spring Harbor Laboratory 1969, pp. 197-207.

Today, this modeling role has been widely taken over by computer modeling. It is a point of discussion whether we can see three-dimensional computer modeling as a continuation of the schematizing visualization of earlier model building. One could as well argue that the three-dimensional modeling of structures and processes *in silico* is a new, qualitatively different procedure that would add to the little typology here, presenting a fourth type of visualization. For the time being, I leave that question open for discussion.

Concluding Remarks

The procedures of visualization in the sciences that I have briefly surveyed here do not occur, as a rule, in isolation from each other. Rather, in a particular experimental context, they are related to each other and are meant to reinforce each other. It is quite usual for all three procedures described in this paper to accompany the text of a single research article. But possibly we should view this the other way around and say that, at least in the case of the modern research article, it is the text that accompanies a shorter or longer series of such visualizations. These visualizations constitute chains or networks of representation in which they refer to each other repeatedly. Insofar as they are the result of and dependent on different technologies, they form what scientists call "independent evidence." The more closely they match, the more stable a finding appears to be. But it is also possible that one representation serves as the raw material for another. As Gaston Bachelard has remarked, the modern sciences are "phenomenotechnologies."[19] They bring their objects to manifest themselves in a process of construction. These manifestations cannot be separated from the technologies that make them possible.

Now, the question remains whether such a typology can help us to think of visualization in exhibitions. I am not an expert in exhibitions, but my guess is that it can. It is my conviction that

[19] Bachelard, Gaston, "Noumène et microphysique" [1931/32], in Etudes, ed. Gaston Bachelard (Paris: Vrin, 1970), 11-24, 18 sq.; Rheinberger, "Gaston Bachelard und der Begriff der ‚Phänomenotechnik'," in id., *Epistemologie des Konkreten*, chapter 2.

in good scientific exhibitions, just as in scientific articles, images, and the objects to which they are tied, should not be decorations or illustrations, they should be arguments. I think it makes sense to analyze epistemic imaging strategies such as the ones described above and to think about whether their peculiar character can be exploited for making meaning in exhibitions. One question then becomes: how can the visualization modes of compression and dilatation, of enhancement, and of schematization be fruitfully modified for making science and scientific thinking tangible? This is the first point. The second point concerns the close interconnectedness among instrumental technologies, scientific objects, and the corresponding forms of visualization. In modern science, it takes the form of a Bachelardian phenomenotechnology with its corresponding technophenomena. This connectedness as well is something that ought to be considered and thought about in exhibition practice. Particular instruments, the corresponding objects, and their visualizations belong to each other and thus can – and should – be made to bear on each other.

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Exhibitions vs. Publications – On Scientific Achievements and their Evaluation

Jochen Brüning

1. The problem

Scholarship aims at describing and explaining certain parts of reality following an established set of methods which is usually embedded in a distinguished community of scholars with similar aims. From early education until retirement, this community of specialists is of vital importance for its members and the course of their career. Mainly for this reason the individual insights gained in the course of continuous labour are given to the attendance of the community and the public at large in the form of scientific "products"; the attention generated by these products is then a measure of the market value of their author(s). We may describe these products generally as "texts" in the most general sense of the word which means everything that is composed in a manner analogous to the fabrication of a woven textile. Such a text has in the first place materiality and shows the same *cohesion* as any woven object like for example a rug, its parts should keep together well and should own some material strength in its entirety. Secondly, if the text carries a symbolic message, as a scholarly production would regularly do, of course, then we require *coherence* in following the coding rules and in composing the whole message from its parts. Such texts will then also serve purposes of *communication* in the sense that their messages are sent by specific authors (the senders) to a specific audience (the receivers) as it is the case for most written texts in the more common sense of the word. The whole composition may, in addition, acquire a certain aesthetic quality, usually referred to as *beauty*, which is hard to assess formally but may add considerably to the interest aroused by the specific product. Finally, it is important to note that, by their longevity, such texts create a world of their own by being taken as a model or a reference or by just being alluded to, explicitly or not; this phenomenon is usually referred to as *intertextuality*.

It is apparent that a single form of such texts, namely the *publication* dominates the field of scholarly production by far, albeit there is a considerable variation in appearance and form depending on the specific subject of scholarship, ranging from sizable monographs written by a single author to short papers coauthored by many, even hundreds of authors. The purpose of this note is to compare this standard format with another extreme covered by the very general interpretation of "text" given above, namely the *exhibition* as a scholarly project and product. We base the discussion on a brief analysis of the modes of production of both formats in the next section. In the third section we will address the "attention measurement" applied to publications and exhibitions by a given community of scholars and its role in the continuous evaluation process conducted by it.

Such a comparison may seem a little awkward at first sight already in regard to the frequency of appearance: Publications outnumber exhibitions by far and they are a privileged scholarly product in many ways: Already the entrance to scholarship, the doctorate, depends on the production of a single-authored monograph, the dissertation, and for many fields publications are the most effective means to inform the corresponding community about recent results; besides, thanks to specific databases publications also provide the most effective way to address the existing knowledge in the respective area.

Exhibitions, on the other hand, are not a natural product for most disciplines but have become more popular and more widespread in recent years, most likely due to the pushing for and the necessity of a greater outreach, especially for the sciences. Experiments often have an inherent quality of making apparent phenomena and their causes, and with not too much more work they may be turned into exhibitions; this can be seen e. g. from the academic evolution of physics education. Besides, the great advantage of exhibitions lies in the fact that they can effectively address audiences of varying expertise in their subject matters, and they have become a product of choice in the endeavour to enhance the public understanding of science and humanities.

Thus there are natural and obvious differences between publications and exhibitions as scholarly products; we will now concentrate first on features they have in common.

2. The production process

Scholarly products arise according to a general scheme which we have described elsewhere.[1] Accordingly, I want to split the production process into three steps which I call

(1) Appropriation,

(2) Assimilation,

(3) Composition.

Typically, these three phases apply to many parts of the whole product and hence will be repeated many times and will also overlap. One should think of them as cycles analogous to the biological cycles occurring in any living organism, simultaneously and in cooperation or competition, but it seems helpful to analyze them separately.

2.1 Appropriation

The first step in any production process, scholarly or not, consists in the acquisition of the relevant material from which the desired product shall be made. These materials will be physical objects which are needed because of certain physical qualities, or because they carry some symbolic content, or for both reasons. The physical nature of the objects acquired is never irrelevant, even though the interest may concentrate entirely on their symbolic content, at the very least for logistic reasons: objects have to be stored and must be handled in a limited time. Thus, appropriation consists in searching the materials relevant to the intended production and storing them. While there are widespread and well tested techniques for storing which we need not discuss, the searching process is not canonical. There are certainly established techniques, too, like the systematic consultation of libraries, archives, or (recently) databases and communication with other experts but there is also the incalculable influence of chance. For this reason, the individual search for relevant material develops into a permanent process which is richly documented by diaries, letters, e-mails, "Zettelkästen", and notebooks of all sorts which are compiled over years; they all testify to a firm belief in serendipity which seems to unite all hunters.

Hence the same principles apply to publications and exhibitions (as well as many other products) as far as the appropriation process is concerned, as is demonstrated particularly clearly through the catalogue of the exhibition (if there is one) which rests upon the same material the exhibition is made from and is produced simultaneously.

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[1] Jochen Brüning, "Wissenschaft und Sammlung," in *Bild, Schrift, Zahl,* ed. S. Krämer and H. Bredekamp (München: Fink 2004), 87-113.

2.2 Assimilation

This second step arises since the material appropriated has to be made "one's own", it has to be incorporated in the context created by the experiences and thoughts of the producing scholar and thus prepared for further use, even if the precise final project or product is not yet known. This process can take many forms depending on the field of production and on the specific habits of each scholar. Usually, a general scheme is employed of ordering the search results into categories and subcategories together with a technique to find them after having them filed away. But very often the item under consideration does not speak for the intended purpose directly, it needs a transformation into the dispositional framework of the scholar who wants to work with it. This may be literally a translation from a foreign language, it may be the reworking of a theme treated with different means and emphasis, or it may be an analysis and ensuing re-expression of a known result in different form, corresponding to the context and the paradigms underlying the ongoing work. In the case of an exhibition, it must be considered how an item shall be presented: as a pure object, as a written description, as a graphic display, as a video piece, alone or in an ensemble etc. Referring again to the text metaphor, we may say that the material produced by the appropriation process must be transformed to a bundle of threads to be woven into a piece of textile as the final product, even if its precise character is not yet determined.

2.3 Composition

In the final step, the acquired and well-prepared material has to be composed into the final product. This activity comprises the design and the ensuing actual composition process. Only through this step the state of completion of a long working process is achieved, and, somewhat mysteriously, the many parts involved are becoming a united whole. All of a sudden, the laborious activities disappear completely and leave a creation, which, in the optimal case, does not show traces of its origin any more. Beyond physical cohesion as the analogue of the technical process of weaving, a new quality of coherence is achieved which assigns to all the individual parts a meaning which they did not have before and unites them into a message which can be communicated. This message is usually not abstract but appeals to the receiver through sensual qualities and may even acquire beauty in the eye of the beholder.

Such description is usually applied to works of art – on which side we are used to see majority of successful exhibitions - whereas a scholarly product is commonly believed to arouse interest only according to a catalogue of formal properties, including novelty, originality, and verifiability. A closer scrutiny, however, reveals that communicative properties play also a very important role for the scholar's work. It seems that this insight is taken into account more often today which brings the two products of interest here, publications and exhibitions, closer together under the perspective of "marketing" which we want to discuss next.

3. The market place

The point of view developed in the previous section certainly provides a basis upon which scholarly publications and exhibitions could be compared, in evaluating the respective quality of the appropriation, the assimilation and the composition involved. However, as mentioned above, an important component consists in the influence of a specific scholarly product on the relevant community. In the sciences this influence has been quantified in terms of "impact factors" which are assigned to certain journals, according to their average quality of articles, and to individuals according to the number of quotations their products experience. However questionable this measure may be in each individual case, it certainly speaks for the importance of the attention which each scholarly publication is able to arouse. Here, of course, the differences between

exhibitions and publications are significant; to describe them more precisely it seems necessary to discuss the communicative role of exhibitions next.

By its very definition, an exhibition is made for the general public or at least the part of it which is used to visit a museum or a similar institution; there are social barriers here which are not relevant to our problem, though. The communicative purpose of an exhibition is therefore multiple, the interested scholarly community makes only for a small part of the audience to be addressed. But there will be very little response in general from the visitors: the guest books usually displayed near the exit of an exhibition seem to stimulate often enough strange emotions, only vaguely connected with the content of the exhibition; the initiated visitor, on the other hand, usually does not give any reaction in public, in particular, scholarly publications concerning specific exhibitions are rare. Such public reactions appear in newspapers, much less in journals, but are written by generalists and not by specialists. More importantly, a widely accepted and coherent framework of comparative exhibition analysis does not seem to exist. In other words, the receivers of the exhibition, as a scholarly product or not, are a somewhat diffuse group. The same is true, to some extent, also for the authors of an exhibition: since a large team is usually working on a sizeable exhibition including scholars, artisans, technicians, designers, and curators, the final product is often not easily attributed to individuals, at least not for the layman. This statement does not imply that an exhibition may not have a considerable impact but if so, this fact can generally not be quantified appropriately.

There is another obvious technical problem: the lack of standardized documentation. In most cases, the catalogue is the only remaining trace of an exhibition but, for small scale enterprises, even this archival item may be absent. Consequently, there is essentially no intertextuality generated by exhibitions beyond anecdotal reference.

In summary, we may say that exhibitions as a scholarly product have production modes analogous to publications but are in general more demanding with respect to time, manpower, and the material aspects involved. While there are, at least in principle, criteria of comparative evaluation, the lack of communicative clarity and easy archival reference has kept the "market value" of exhibitions in communities of scholars at a relatively low level so far.

This state of affairs may change, though. We have seen recently that other evaluation criteria than the quality of publications have entered the world of scholarship, notably the amount of third party funding acquired and the (proven) administrative ability to organize large cooperating research units. Both these activities necessitate a certain amount of what is now called "outreach", a term that refers elegantly to qualified advertising. The need to compete for attention as the basis of substantial support cannot be denied since the public funding of scholarship is, on average, decreasing continuously. Here, small scale exhibitions may play an increasingly important role in view of their persuasive features described above, much in the same way they work now for commercial fairs. It is imaginable that a further creative and scholarly development of the production and referencing techniques will lead to the acknowledgement of exhibitions as a scholarly product with appropriate evaluation criteria. Such a development would also enhance the public understanding of science and humanities and would, at the same time, enrich academic education as well.

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Power, Belief and Trust – A Context for Scholarly Priorities in the History of Science

Robert Bud

Exhibitions exploring the history of science in major national museums have too much potential to be based on just history. Historical exhibitions are presented at huge expense to address potentially large audiences. The justification may be pleasure but this can be a deeper experience than momentary curiosity. In the modern era, science has served as more than a system of research findings: it has structured all knowledge. When we are presenting its history to audiences needy for meaning and orientation in a chaotic world we have a responsibility to create real works of art.[1]

If one takes this ambition seriously, research begins not with the past, but with the present and the future. What are the public's needs to conduct their own lives?

Just think of the awesome challenges. Many people are well informed about science and take part enthusiastically in the numerous debates that reflect fundamental values today: cloning hybrid human/animal embryos, developing genetically modified crops, planning space missions and new nuclear power stations; how to provide global leadership in controlling carbon dioxide emissions. But many others are nervous, knowing little about science and feeling that they are not entitled to take part or qualified or that science is too alien to their own cultures for them to care.

A large number of surveys both from Europe and the UK report these anxieties, which are based far more on cultural clashes between the many lay cultures and official scientific cultures than just on simple ignorance. In the UK, prophets of science such as Richard Dawkins have denounced the belief in religion. Believers are either simple or foolish or both. On the other hand, the numbers of such miscreants is too large for them to be dismissed so lightly. Nor is the public particularly respectful of the benefits of science. Since 1992, only half of Europe's population has agreed with the statement, that "the benefits of science are greater than its harmful effects".[2] A quarter holds the contrary opinion; a further quarter has no opinion. In Britain, the statement "Scientists are responsible for the misuse of their discoveries by others" elicits almost as much agreement (42.8%) as disagreement (42.3%) in Britain.[3]

The Science Museum is already one of Britain's principal fora for the presentation and discussion of major scientific issues. With two to three million visitors each year, one fifth of the entire British population have already visited sometime in their lives.[4] In this museum, we present science and engineering of the past and the present. We also tell visitors some of the relationships between people and machines.

Beyond the question of what anxieties and concerns we address, are the issues of how. The second kind of research, therefore, that we need both to benefit from and contribute to is the rhetoric of the museum. How do we communicate with our visitors? Certainly the design of the

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1 Robert Bud, "Science, Meaning and Myth in the Museum," *Public Understanding of Science* 4 (1995): 1-16.

2 Europeans, Science and Technology, Special Eurobarometer 224 / Wave 63.1 – TNS Opinion & Social, 57.

3 Ibid, QA 15A.

4 MORI, "Science in Society," Conducted for the Office of Science and Technology, Department of Trade and Industry, March 2005, 49.

exhibits and the way in which this communicates and emphasises the communicative power of artefacts and multimedia, art and text is important. At the meeting, the question was raised about the significance of the presence of the object. This can have great communicative power. So can the narrative, which links the components and highlights the coherence of the experience. More poetically, we engage in history and storytelling. Of course we do not recount history in the traditionally academic sense. Most of our users are not principally interested in history for its own sake. Rather the Museum is concerned with parables and allegories that use narratives, which are absolutely accurate of course, to tell stories which have a resonance today.[5] The story telling qualities of history can help audiences put present crises in context and give a sense of shared experience. One need not of course, one cannot, immediately jump to the conclusion that some form of existing historiography of science needs but to be expressed in a simple way.

The historic and contemporary collections built up over a century and a half are used to tell those stories in that unique way open only to the object-rich museum. The objects and their collection are not secondary to the audience, our ownership of them and our understanding of their rich potential represent our unique resources in a world of competing voices.

Only thirdly can we focus our attention on the content of the narrative and the historical developments. In keeping with my model of narrative with a poetic meaning for the present, we have both to be accurate and heed Ranke's injunction to understand history 'wie es eigentlich gewesen ist,' but also to think about what aspect will have resonance and meaning today.

I wish now to make this interpretation less abstract and relate it to a gallery on science that we are currently developing. Now we are envisaging an exhibit on science addressing half a million visitors or more each year, which will engage with five to ten million people in its life time. Not only is this far greater than the readership of any book about the history of science, it also exceeds, in Britain at least, the audience of any recent serious television programme about science. Moreover, the impact is not made on a single night but is prolonged over the period of half a generation. We will also build at the same time an exhibition dealing with modern communications. Websites associated with these exhibits may double again their reach in numbers, and in geography reach out across the whole world.

What has already become clear is that these three levels have to be pursued together and in parallel. The visitors are rarely sufficiently self-aware to answer enquiries in abstract. Discourse with groups needs to test hypotheses drawing on what we can contribute to help us better understand what they might want to experience.

This paper cannot deal with the whole scope of an exhibition that is currently being developed and will not be completed for several years. Instead it will deal with a single aspect that has been the topic of the author's concern for some time. Museums are often concerned with making sense of boundaries, for objects focus the visitor's attention on classification and ambiguity. In the case of science, we have a rich supply of boundaries to explore: between the scientist and the layperson, between scientific and lay knowledge, between reason and conviction, science and belief, and between teachers and students. At issue are such diverse major topics as risk on the one hand, and the claims of scientific and Biblical truths on the other.

There is of course a question to be raised as one examines this challenge. What do you mean by science? How is it defined? One way, I suggest, how we can help people make sense of these slippery categories is to think of science as a brand. Many brands are carefully crafted by suppliers. However, such an active single agency is not necessary. Nor is the concept of brand restricted to particular trademarked varieties. "French wine" or "Swiss watches" have assured qualities that go beyond the marketing of individual marques. A generation of social anthropologists has looked at

[5] Bud, "Science, Meaning and Myth in the Museum."

the "world of goods", and has found in consumption the sources of personal identity. Whereas it is commonplace to observe symbolic personal battles fought out through the choice of cars and clothes, remarkably, science has not generally been examined in this way. Yet in the case of science too, we need to combine an understanding of symbolic significance with the appreciation of technical performance.

An early work of Baudrillard, *Le systéme des objets,* published in 1968, dealt with the interpretation of the brand as a quality, which condenses the symbolic and instrumental value of a commodity.[6] Baudrillard also looked beyond the strictly academic literature and cited at length the work of two men who were addressing themselves to business in the interpretation of a new world: the Austrian immigrant to the United States, Ernest Dichter, and the French writer on business, Pierre Martineau. Even Vance Packard, author of the 1957 denunciation of modern marketing entitled *The Hidden Persuaders*, testified to Dichter's effectiveness.[7] For Dichter, trained in Vienna in psychoanalysis, users co-constructed brands to help develop their own identities, and he was anxious to warn doctors that like other suppliers they needed to treat clients as partners rather than as supplicants.

As well as the work of Dichter, Baudrillard cited the 1957 volume by French business writer Pierre Martineau, *Motivation in Advertising. Motives that Make People Buy*. This book explored the meaning of instant coffee and the subtle differences in meaning that this drink had acquired from ground coffee. "When people become articulate about coffee," he wrote, "they go way beyond any drab drink which is on the table three times a day like a glass of water."[8] Not only was instant coffee considered "economical," it was also "suited to young people, rushing to get to work, progressive. This means they are youthful, busy, hardworking, up to date, smart, clever enough to use modern innovations."[11]

Similarly, I would contend, science has the quality of a 'brand' which is flexible and indeed increasingly used as part of advertising to validate other brands. This is not to trivialize the subject, rather it is to work at the level of the users' and visitors' cultures, and to work at genuinely engaging the millions of people who will pass through our doors. At the same time, we need to explain the practices that underpin the brand, for no successful brand is based entirely on marketing. Similarly, there are scientific methods and processes, and important principles such as the dependence of science on measurement and mathematics.

To address visitors' concerns and to draw on our strengths, the Museum proposes to explore science through the qualities which make it such a cogent generator of truth but also its power which elicits both wonder and fear, belief in its ability to yield truths and to resolve problems, and trust in the institutions of science.

Wonder and fear at the power of science are well expressed by the complaint now often expressed, but not new, that scientists are playing God. There are historic examples, most famously of Oppenheimer, on witnessing the first atomic bomb test as well as contemporary concerns expressed most often about recombinant DNA.

Of course we do not need to show only historic examples of problems. The contemporary and historic belief in science as a solution for problems has many stories back to the French Revolutionary wars and up to the present rapid development of India and China. The belief of the public is not the only kind of belief at stake. By contrast there are stories of doubt, most obviously

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6 Jean Baudrillard, *Le système des objets* (Gallimard, 1968).

7 Vance Packard, *The Hidden Persuaders* (London: 1960, first published 1957), 32-34.

8 Pierre Martineau, *Motivation in Advertising. Motives that Make People Buy* (New York: McGraw Hill, 1957), 54.

today in the debates over the status of evolutionary teaching as an explanation for the origin of the human but also of the cellular description of a foetus.

Belief in science does not necessarily equate to trust in the dominant institutions of science. Environmental groups may believe passionately in the potential of scientific analysis and query profoundly the integrity of companies and governments which are the dominant interpreters of science. The debates over the use of genetically modified organisms are at one level arguments over whether the critics are distrustful of business or disbelieving of the potential of science. Of course these categories of belief, trust and brand are analytical concepts useful for the exhibit developer. They are not necessarily the best words to present to the public or even the categories which would be exposed.

Interpretations that stimulate thought about the place of the science brand can contribute to its history more generally. Historical works by journalists often using simplistic historiographic approaches and drawing naive conclusions are dominating the trade press in our field. People, who take the academic study of the field seriously, need to develop a rhetoric, which reaches out successfully to large audiences and meets the needs of people desperate for meaning in a chaotic world.

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Thinking Through Objects

Martha Fleming

'Thinking through objects' is not at all the same thing as 'showing through objects.' With a leap we go beyond objects as illustration and the instrumentalisation of material culture. We are here today because we want to find ways to articulate what exhibitions can do for scholarship that publications cannot. Having made both I believe that the key lies in the practice, mechanics, rhetorics and techniques of exhibition *making* rather than in the final exhibition itself – though the process always shows through in the product. As scholars, reflecting on *what kinds of advancements in thought can be made* during the research, development and production of exhibitions is a much more radical and fundamental act for us to effect here than that of exercising our critical faculties as consumers of the knowledge-products of exhibitions. What we are essentially talking about here is how – and why – to think through objects and space rather than through words and pictures: different intellectual practices in short. I would thus like to re-interpret the title of the symposium as "*the Exhibition as a* Project *of Scholarship*."

As we ask the questions, what is a book, what is an exhibition, and precisely how are these two things similar, different and related, the question 'what is scholarship' will quietly doubtless pervade the whole exploration of this symposium. What constitutes scholarship may well itself come under some stress as well as scrutiny. In an era of dubious but unavoidable metric evaluation of 'outcomes' for the benchmarking of quality in university research, the 'exhibition' becomes a form through which scholars can extend their reach. But the exhibition is such a different beast to a book that it is worth having a closer look before the uninitiated jump in. The practice of making exhibitions is a highly developed professional activity: good curators, artists and designers are all of necessity highly skilled researchers and answer already to a rigorous and demanding process of evaluation outside the groves of academe. Our conversation here must go much further than examining the use of object-images in publications, or the use of texts in exhibitions, or even the various forms of funding recently becoming available to wed the deficit-weakened museum research community to a humanities community newly awakened to the power of material culture[1]. It would be worth looking at some hybrids and crossovers here to situate ourselves.

We must start with antinomy in order to go beyond it: an insult often leveled against an exhibition is that it 'looks like a book on a wall.' Long screeds of textual info peppered with illustrations which occult a view of the objects themselves is sure to garner this moniker. Such displays give the impression that the objects are reduced to illustrative images to accompany text; subjugated to it.

There is, however, a scholarly reciprocity between books and exhibitions beyond the convention of the catalogue as a ligature. It is worth looking at this reciprocity from the longer, wider view as well. It's not just that people make books on walls or exhibitions in books: the two forms do deeply inform each other when they are not being confounded. For example, it would have been impossible for Jean Clair to have produced the exhibition *L'ame au Corps* in 1993 if there had been no Michel Foucault to spatialise disease for him, and for all of us. This notion of the 'spaces of illness' is almost *made* for the 3D surround of exhibitions, and indeed this and other textually expressed

[1] As an example of new funding for humanities/museum research, the advent of the accession of the Arts and Humanities Research Board to the status of a Research Council in the UK in 2005 cascaded funds towards museum research activities by recognising them as "Independent Research Organisations."

rhetorical-theoretical notions referencing space are in turn 'made' from the larger lessons of architecture.

Great works of cultural history have *appeared* as books and yet have the spine-tingling spatial power of exhibitions: their innovative methodologies have burst out of the pages and altered the form and content of both books and exhibitions; I am thinking here of Siegfried Giedion's *Mechanization Takes Command* (1948), for example.

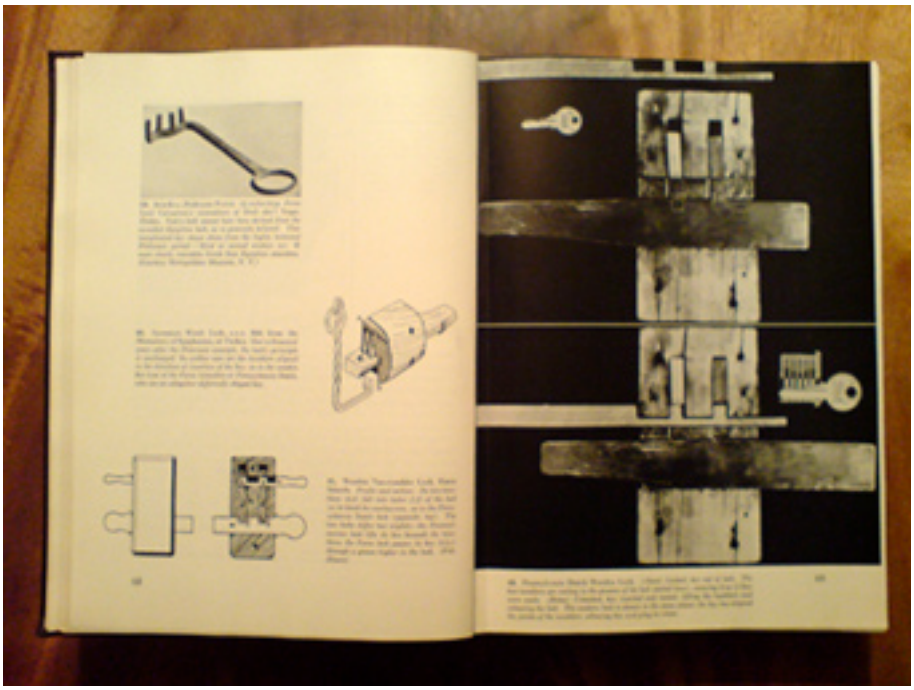

Figure 1: Pagespread from *Mechanisation Takes Command* (Giedion, 1948) (photo: Martha Fleming).

Giedion thanks, in his foreword to *Mechanisation*, two great artists of space for their help – the sculptor, designer, and photographer Laszlo Moholy-Nagy, and the graphic designer, typographer and architect Herbert Bayer. Bayer helped create the layout of the first edition of *Mechanisation*, and the deep space of the pages he created, informed as they are by his knowledge of both sculpture and architecture, make each chapter a resonant gallery with depth of field and texture. The material illustrated in this book could still, half a century later, be taken straight out of the pages and into gallery spaces to great effect, because the relationship between the objects which are pictured in 2D *has been conceived in relation to their materiality and three-dimensionality*, as well as in relation to complex representational registers between diagram and photograph.

I hope you can see that what I am pleading for here is a continuity between book and show rather than a hierarchy or even an equivalence between them. We need to find complementary parallels between these two great forms – rather like those which exist between music and theatre – and the bridges which directly link them at certain points along their separate flows.

This does require that we do a little mapping. In the last few pages I have looked at these issues as a consumer of books and of exhibitions, but what are the conditions of *research practice* of these two forms, what do each offer the researcher? What does one have to learn to master technically in each case?

Both of these forms, books and exhibitions, ostensibly begin with a research question of some sort. The fetishisation of research questions inside humanities scholarship bears a relation to their fetishisation within science: in point of fact, they are points of departure and not framing devices or methodological tools. Along the way, research and experiment always push back up into the research questions, reshaping them, and there is knowledge on the part of anyone who has ever done any really groundbreaking work that nothing of any interest ever comes out of doggedly pursuing the exact parameters of a research question set before the real work begins. More often than not, research questions too strongly adhered to produce tautologies: and those, which are slowly rewritten along the way, appear strangely rhetorical in the end... What this points to is that real scholarship is actually embodied in methods, and methods are as unique as the subjects from which they spring. When they can be extrapolated and generalised, it is methodologies that are thus the *real* product of scholarship.

Both books and exhibitions have structural conventions of form, and they also have rhetorical devices: above all they have contents – in the case of exhibitions, these 'contents' are sometimes very unwieldy indeed. Managing these conventions, these devices and these contents *around* the subject of inquiry is the *practice* entailed in making books and in making exhibitions – the research, if you will. It is the spinning engine of the scholar's research practice that generates new knowledge between these three poles – conventions, devices, contents: new methodologies are extruded from this engine, and *it is the methodologies that are the scholarly product of research*, as much as the actual tomes or shows produced. If the scholarship inheres in the practice, not just in the product, then books and exhibitions are both equally forms of scholarship.

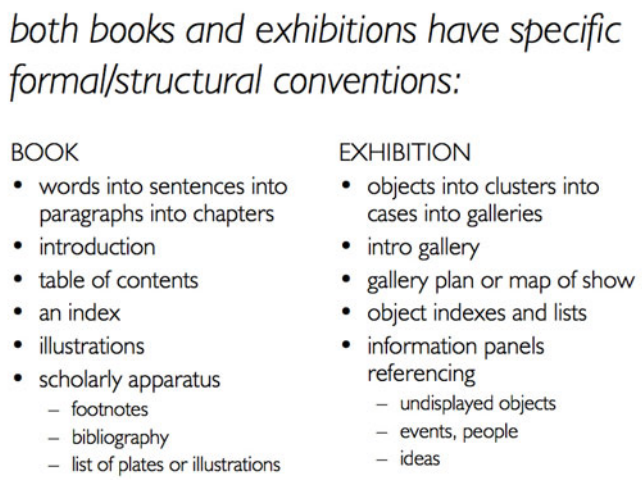

Figure 2

A scholarly book has words arranged in sentences, arranged in paragraphs, arranged in sections, arranged in chapters. It has an introduction, a table of contents, often nowadays illustrations, and an index. It has scholarly apparati such as footnotes, a bibliography and a list of plates or illustrations that firmly root it in all that has gone before. It is a filigree grid of knowledge accessible from multiple entry points.

A museum exhibition has objects, arranged in clusters, arranged in cases, arranged in rooms. It has an opening room, which orientates the visitor, and often a leaflet that gives a plan of the disposition of the galleries and the section subjects of those galleries. It has an object index, often correlated by numbers positioned next to the objects in the cases, and often displayed in or on the

case itself. It has text panels which give background information about the overall subject of the individual gallery or case, and which often reference other objects, events, people and ideas which are not 'on display'. It is a filigree grid of knowledge accessible from multiple entry points.

This comparison is clunky and reductive, and we would all agree that a constellation of words is an entirely different thing to a constellation of objects, the creation of which requires different practices, and which are subject to different cultural conventions and even different natural laws. Yet both constellations *make meaning*, and this is what is of interest to us as scholars. We need to be as interested in *how meaning is made* as we are interested in what meanings are made by our constellations of words and of objects. But where have we heard this before as a problematic on a continuum – objects, space, words and pictures?

The 'picture theory' that has been absorbed into the canon of Wittgensteinian linguistics actually originates in the very beginning of the *Tractatus Logico-Philosophicus* (Pears/McGuinness translation,1974), a section which addresses *objects* above all; not words or images. The austere intensity of the first few pages of the work, before the word 'picture' even appears in proposition 2.0212, clearly delineates the primacy of, and the inseparability of, objects and states of affairs. Throughout the *Tractatus*, Wittgenstein reiterates that it is from the nexus of object relations that 'pictures' or hypotheses issue forth. The 'pictures' themselves are part paradigm, part diagram, and not uniquely composed of language -- rather, his is a syntax of object relations. I have found these few first pages of the *Tractatus* consistently illuminating in relation to what actually happens when we physically put objects together, arranging them and rearranging them.

2.0121 If things can occur in states of affairs, this possibility must be in them from the beginning.

...

If I can imagine objects combined in states of affairs, I cannot imagine them excluded from the *possibility* of such combinations.

2.0141 The possibility of its occurring in states of affairs is the form of an object.

2.0271 Objects are what is unalterable and subsistent; their configuration is what is changing and unstable.

2.0272 The configuration of objects produces states of affairs.

2.03 In a state of affairs objects fit into one another like the links of a chain.

(Wittgenstein, 1974: 6-8)

Atomism & Animism, my exhibition at the Science Museum, London, of a decade ago, was above all an intervention *in* a field which was an intervention *about* that field. As a collection interpretation, its basic assumption was that objects can be subject to multiple interpretations and have an innate capacity therefore to signify concurrently in a number of different and sometimes even conflicting registers: the chronological, the formal, the disciplinary, the aesthetic. If this quality of ambiguity is embraced, and used skillfully with attention to equally multiple contexts, it means that individual objects can become pivots, or hinges, between separate thoughts and even separate modes of thinking: careful juxtaposition of objects can actually produce new thoughts and new ways of thinking.

Figure 3: Crystal model set in book-shaped box illustrating Rome de l'Isle's *Crystalllographie* (Paris, 1783). Collection: Science Museum London (courtesy of Science Museum, London).

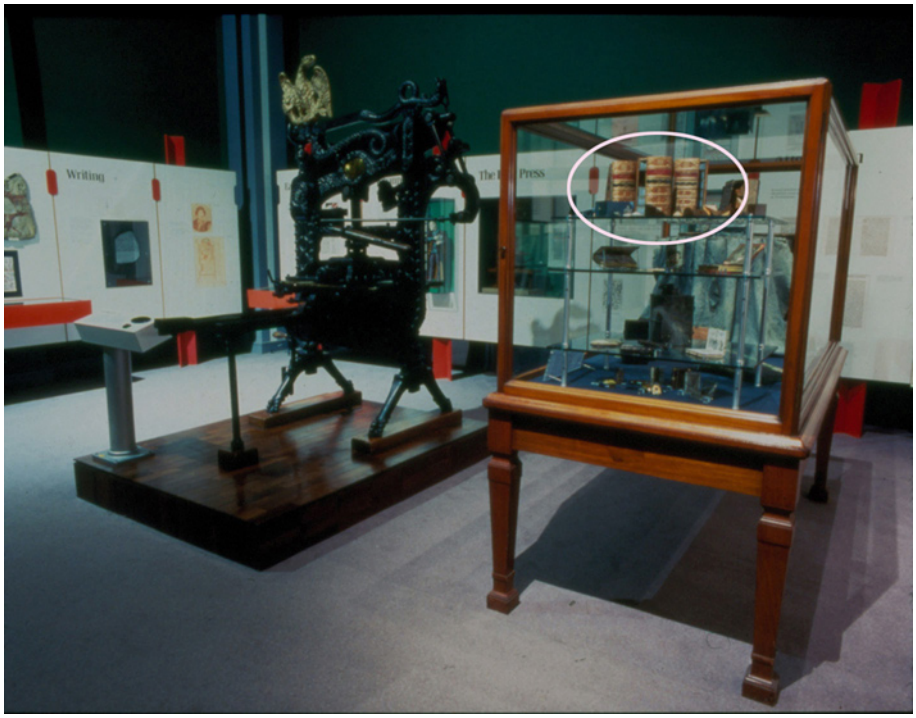

Figure 4: "*The Library*", a case of book-objects and book-instruments from the Science Museum collection (includes de l'Isle, *Crystalllographie*). One of 16 installations from the exhibition *Atomism & Animism* (Martha Fleming, 1999, Science Museum London, courtesy of Science Museum London, photo: Martha Fleming).

Figure 5: Model of the Slave Ship Brooks, Wilberforce Museum, Hull (courtesy of Hull Wilberforce Museum, Hull).

Figure 6: *"Cargo"*: model of the Brooks inserted beside the model of the Mayflower, Shipping Galleries, Science Museum London. One of 16 installations from the exhibition *Atomism & Animism* (Martha Fleming, 1999, courtesy of Science Museum London, photo: Martha Fleming).

Figure 7: Detail, cabinet of disks and spheres in foreground: *Atomism & Animism* (Martha Fleming, 1999, Science Museum London, courtesy of Science Museum London, photo: Martha Fleming).

Those who have never made a museum exhibition would find it hard to imagine the complexity of the process in sheer logistical terms. Imagine how much greater the frustration of obtaining picture rights for a publication would be if you were, instead, trying to get not the image, but the actual object, delivered to your office door. As most of us are interdisciplinary scholars, multiply all that to the power of ten, because you will be doing something which has ambitions to cross the disciplines which are reflected in a museum's very structure – its storeroom arrangement, its registration and database structure, the distribution and hierarchy of its curatorial and collection management staff. This is what you can expect when you want to start moving objects around as you might phonemes of language and sentences of text. It is a time consuming, detail-dependent business, not for the faint-hearted.

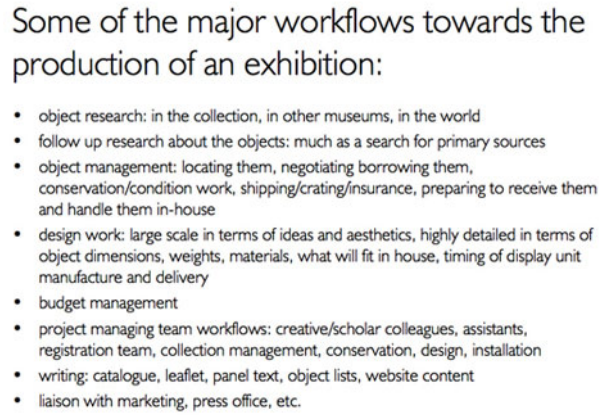

Figure 8

Why is it worth moving our objects, those unwieldy pieces, around? Certainly not just to illustrate ideas already formulated in other fields: this is not the chessboard of the Red Queen. What is

amazing is what emerges from forms of analysis that are not textual, that have to do with the fundamental material composition and the resonant capacity of objects to register in a range of contexts. But though the constellations of objects that compose an exhibition are '*of representation*,' the individual objects are not. Let's start with them, and at least try to do them some justice, however contentious any claims may be. Let's start with an object, not an idea, and see how many ideas objects can give us.

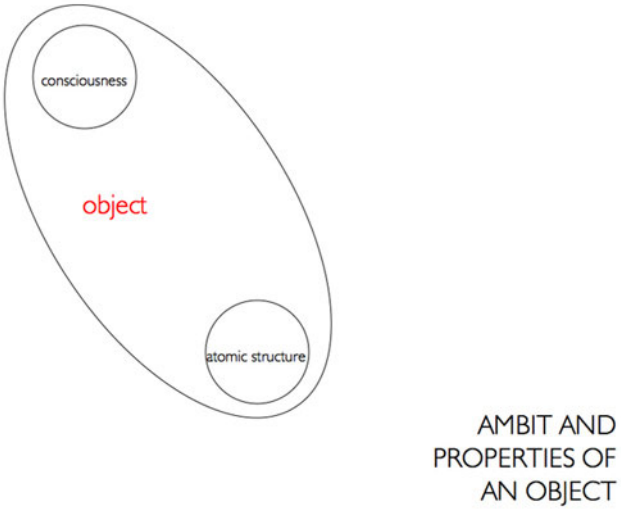

Figure 9

The more work I do with objects, the more I feel that there is some kind of link between their atomic structure and what we have called consciousness, even if we limit that consciousness solely to the one we attribute to the exhibition team members, and then to the exhibition visitors.

The atomic structure of the object delineates what most would recognise as the distinct materials of which it is composed, and consequently the forms it takes.

Further, the object can be approached historically, looking at its place in various developments, situating its various moments in time, its actual function inside a discipline or an activity, or its aesthetic qualities, which may in some way be a clue to how to talk about all these things together.

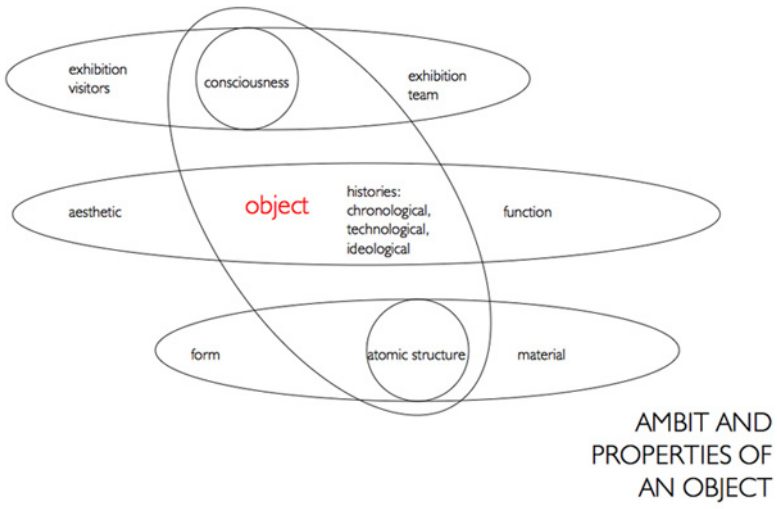

Figure 10

Building on this, techniques and methodologies of bringing several objects together can take any one or grouping of these many trajectories as an organising principle for analytical association, and each trajectory will reveal to the researcher much more than the sum of the parts of the objects assembled. These are 'force fields' in which the objects are suspended in much the way that the atomic structure of the materials of objects are 'force fields' which make them up.

Objects of similar forms can be brought together from very disparate disciplines to explore how laws of physics define even those ostensible abstracts, platonic shapes. Objects of similar material can be brought together to discover how that material both functions and signifies in different realms.

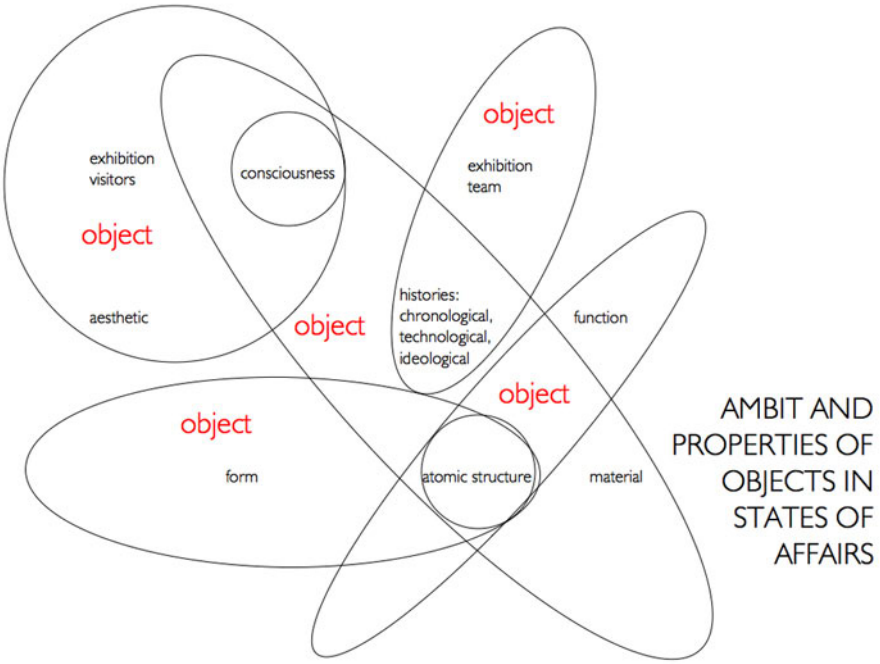

Figure 11

Figure 12: *"Cones"*: one of 16 installations from the exhibition *Atomism & Animism* (Martha Fleming, 1999, Science Museum London, courtesy of Science Museum London, photo: Martha Fleming).

As it has been pointed out by the organisers of this symposium, we do not yet have a language to discuss objects and exhibitions in relation to their value to scholarship. I believe that this is in part due to the lack of development of aesthetics into a discipline capable of tracing the evident link between matter and praxis, and even between production and reception. How does what we learn from thinking through objects transpire from them in exhibition to the point where it is received by the visitor? I believe that it will only be when enough work and attention has been paid to transforming aesthetics from a heuristic practice into a regimen equivalent in some way to a precise logic of mobile subjectivity that we will find ourselves with a language to discuss what actually happens between us and objects in the process of making the representational constellations that we call exhibitions. We may discover that aesthetics, once honed, can be as incisive and analytical a tool as epistemics; even complementary to it into the bargain.

This is about recognising and investigating a deep-structure for aesthetics: that the surfaces of things and how they appear tell us much about their make-up, both at an atomic/material level and also at the level of choices made in relation to the manipulation of that material (raw or otherwise) by the subjectivities which handle it. Aesthetics is actually not just a question of individual tastes varying from domain to domain, but rather it concerns the experiential framework for judgement, both in making and in interpreting meaning – and thus implies informed judgement about structure itself. It involves the use of the senses, experience and cognition as a calibration technique for evaluating and organising new information.

What then *are* the techniques of the representational discourse? What are the practices of making exhibitions that convey meaning? Conceptualising exhibitions, designing the way those constellations of objects will look to a person other than the person who has made meaning in so constellating them, involves deploying as many representational techniques as does writing. One can use objects in similar ways to words: objects can be metaphors, partake of metonymy, synecdoche, allegory, allusion, analogy. Also like words, one can string them together in narratives, in causal relations, in antithesis, chronology or diachrony. One can use relational techniques such as Humour, Intimacy, Distantiation.

And one can use techniques that are not so easily deployed with words, techniques specific to space:

Perspective

Sight Lines

Scale

Colour

Light

Reflections

Transparency/Opacity

Surfaces/Textures

Time

Sound

Spatial Divisions

between rooms

inside the room volumes

using room heights

floors as well as walls

... as well as disposing objects inside Information Design tools such as Grids, Flow Charts and the like

... there are also contextual techniques such as

working with and against the architecture

subverting the intended use of tools and machines to 'show the apparatus'

being constructively self-reflexive, showing our position as curators, maintaining our criticality about the process of exhibiting itself

One can see here that these techniques are highly structured; can we find ways to work from design methods back into epistemological ones? The inverse might then also become possible – to find a route out of epistemological inquiry which leads directly into innovative display techniques.

Above and beyond the difficulty of humanities scholars getting close enough to objects on a regular basis to develop quite literally a *feel* for them, how does one learn the visual, spatial and phenomenological skills of exhibition making as a humanities scholar? I'd like to give a little vignette from the project I am working on now in order to show you some hybrid methodologies in action and in the making; instances where close attention to objects has extruded new thoughts and new methodologies of meaning-making.

The project in question is *Biomedicine on Display*, an exhibition being developed at the Medicinsk Museion of the University of Copenhagen, and it involves making visible some very intangible processes of biomedicine as well as abstract concepts about those practices. Director Thomas Söderqvist's core vision for the Museion has been to link the research of scholars of history and philosophy of contemporary biomedicine with the collection practices of the museum itself. This is a firm base, but one cannot make an exhibition solely out of the artefacts of biomedicine alone any more than one can write about biomedicine critically by using solely words developed in biomedical practice.

First, I collaborated with the Museion to develop an international closed workshop on biomedicine, aesthetics and museum practice. We brought together artists, designers, biomedical practitioners, philosophers of medicine and biotechnology, historians of medicine and of art, and museum professionals in August of 2007. I was then invited to be the Creative Director of the exhibition itself: when work began, I was the only person with exhibition experience on the team. I began by structuring a series of extended brainstorms with the core group of about six researchers. I asked people to bring objects to a number of these early brainstorms.

Figure 13: Waste tissue disposal canister from abortion apparatus. (Courtesy of Medicinsk Museion Collection, Copenhagen, photo: Martha Fleming).

Here is an object, which was brought by Sniff Andersen Nexoe, whose important work focuses on fertility, foetuses, abortion and the social structures that create these practices and subsequently are created by them. This entirely non-descript plastic object is a container for foetal remains

which is the disposable part of an abortion apparatus. After much discussion, it became clear that the container itself in some social contexts is made to perform the inadvertent function of attributing personhood to its contents. So this non-descript object is actually incredibly volatile socially and has highly significant roles, which it plays. From the discussion about this object came the realisation that biomedical 'containment' and containers are a mechanism of the instantiation of personhood: it became one of the core organising principles of the exhibition we will open next June. This principle is also one of the ways we will be able to connect directly to the visitor.

Figure 14: Single use, disposable plastic labware and sample containers, straw pipette, two microwells, two pipette tips, urine sample container, stackable culture flask. Medicinsk Museion Collection, Copenhagen. (Courtesy of Medicinsk Museion Collection, Copenhagen, photo: Martha Fleming).

This little group of objects, also all of them disposable, were brought to the table by Thomas Soderqvist during a brainstorm about tactility. They, too, resonate with the capacity to contain, but perhaps show more clearly *what* there is to contain: much biomedicine is about managing liquidity. During the conversation, we realised that this is something that biomedicine shares with medicine down through history – it might be possible to show this continuity in comparing these with other historical objects perhaps more familiar to the visitor. But the disposable plastic of the biomedical lab has more to tell us: Susanne Bauer, epistemologist of epidemiology, pointed out that the microwell plate has a grid so that the liquidity of the matter within it can be correlated directly into the data streams of biomedicine, something she has been concerned to materialise in the exhibition. Between liquidity and containment there is flow.

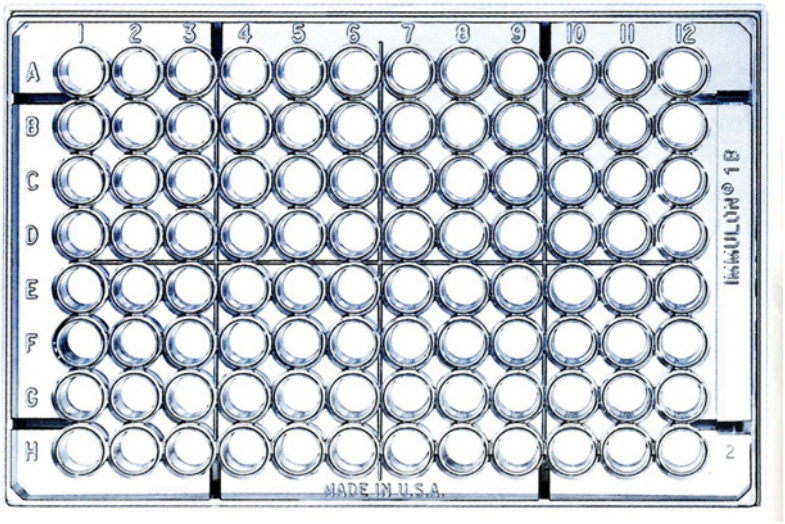

Figure 15: 96 Well Microwell or Microplate for storing and analysing biological microsamples. (Courtesy of Thermo Fisher Scientific, USA).

Containment, Flow, Personhood, Data Streams, Tactility. Thus the first room of our exhibition which we created was our proposed Container Wall, a huge scale model of a microwell plate each well of which will contain an historical or a contemporary object used to contain the liquidity of life – an exploration of biomedical practice on a continuum and also a metaphor for the fragmentation of the body that is anatomy's legacy to biomedicine. The visitor will be able to touch, and to taxonomically rearrange, all the plastic objects at will, and relate them through the perspex of the microwell with medicine's past.

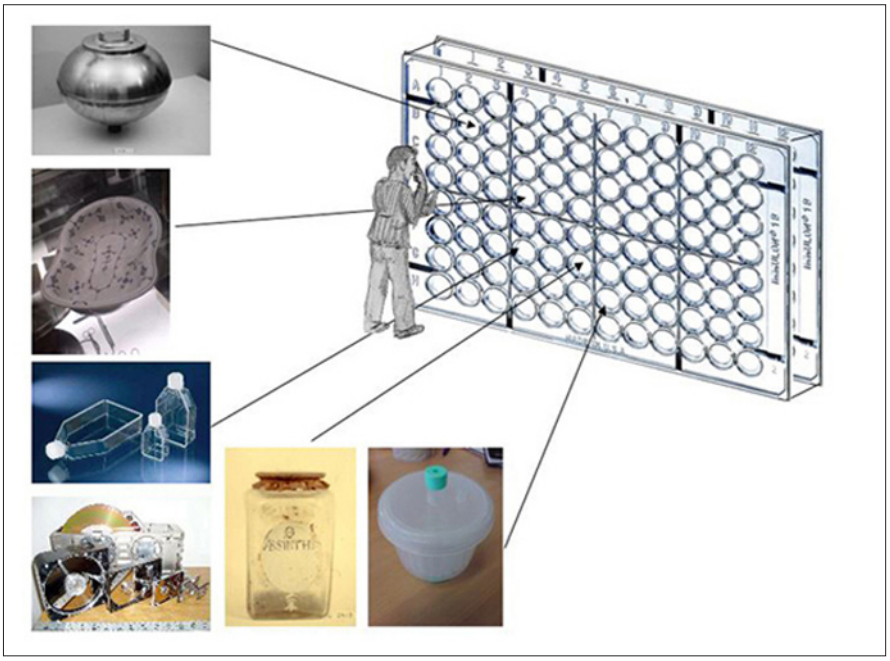

Figure 16: Visualisation sketch of giant 'microwell' display case for Biomedicine on Display project, Medicinsk Museion, Copenhagen. (Courtesy of Medicinsk Museion, Copenhagen, photo: Martha Fleming).

I hope I have been able to show how objects can be a central part of an intellectual process, how close attention to them feeds research, how methodologies issue from our meaning-making with them. We bring them together for ourselves in a scholarly practice; we bring them together for others in an exhibition context. Such is the richness of objects that each time they tell us something new; each time, we too, tell something anew with them.

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Exhibition Making as Knowledge Production, or: Struggling with Artefacts, Visuals and Topographies

Walter Hauser

In the following paper I shall describe an intriguing experience, namely that of exhibition making as a process of knowledge production. This actually arises less from academic scholarship than from practice, that is to say from the development of a real product in space. This paper is a reflection on seven years of work on an exhibition which will present contemporary research in nano and biotechnology to a broad public. It describes the protracted path of collecting and researching artefacts, the permanent challenges to our concept in an often difficult interdisciplinary dialogue with scholars from within and outside the science community, and finally the struggle with the very specific publication format of an exhibition. The exhibition format – currently only materialised in form of a storyboard – not only presented us with some innate idiosyncrasies during this process; it also proved itself to be much more than a mere instrument of visualisation or publication, moreover being a productive epistemic tool.

As the exhibition will not open until 2009, the product is not even finished yet. In this respect the following notes are necessarily fragmentary. Only a few modest pictures are therefore included in this paper. Of course, only by actually visiting the real exhibition will it be possible to verify whether and how the exhibition really "works", especially whether it proves itself to be illuminative to the future visitor.

It appears to be widely accepted that the work of an exhibition curator is to be regarded in a scholarly research context. At the very least this is true for historical exhibitions, with research on museum artefacts being at the heart of the curatorial work. In actual fact this seems to be much more valid since the humanities have taken a material turn. But whereas in some areas – such as archaeology, for example – artefacts are quite naturally valued as an epistemic source in their own right, I have still the impression that artefacts from science and technology museum collections are not; they are mostly used to just illustrate and visualize research results which rely primarily on written sources.

Many of the large historical exhibitions of the past decades (historical in the sense of cultural history) have also inspired academic work beyond the mere factual research on and the decoding of artefacts. This is because the curators understood their job as a creative work of image and knowledge production in its own right. To cite a popular German anthology of Gottfried Korff and Martin Roth, museums and exhibitions are not just a playhouse of history but also a "laboratory", at which point scenography comes into play. Scenography is able to create visual sceneries which provide insight, a sort of thinking in "Raumbildern"; therein it puts the curatorial hypotheses on trial (like scientific work does). It brings the artefacts to the point that they appear to "talk" to one another and to the contemplator, thus producing meaning. Scenography thus opens a productive space for knowledge, albeit a rather associative and ambivalent one. The role model for this is less academic scholarship than the visual and rhetoric arts, and in a sense exhibitions are like literary fictions. Being fictional constructions as well as based on scholarly factual research they reside at the interface of scholarly and artistic practice.

There is thus a pertinent museological literature which highly values the exhibition experience as a "school of perception" and an illuminative, not just as an illustrative knowledge space in its own right (Korff, 2002). But still some questions remain. As one of its proponents, Gottfried Korff

once remarked that the massive catalogues which always accompany the typical exhibition suggest a rather weak confidence in the exhibition format. What these catalogues impressively do is to demonstrate the exhibition as a generator and product of scholarship – but what about the exhibition in itself? And secondly, what about exhibitions which are definitely not historical, for example those centred on contemporary science and technology instead of the humanities? Often enough these can neither rely on the aesthetics of the artefact nor on its "auratic" qualities or emotional meanings. Thus, important ingredients of what is called the scenography of an exhibition are to some extent missing.

The museological framework referred to above still seems to be quite distant from the practice of a museum of science and technology, especially when it follows the current trend to focus more on recent developments in science and technology. This can be illustrated in detail by reviewing one example of an exhibition project at the Deutsches Museum dealing with contemporary science. However, as the interest here is in the specifics of the exhibition format and especially of exhibition *making* as a process of knowledge production, the focus will not be on the alleged learning experience of the future visitor – which of course was also a main concern for us – but instead on the learning process of the curators in developing the exhibition.

The Public Understanding of Research Approach

Our project started neither with a collection of artefacts nor with the idea of a historical reconstruction, but, to state it simply, with a Public Understanding of Science mission, namely to make recent developments in nano and biotechnology accessible to a broad audience. Another important aspect was that the exhibition, whilst focussing on contemporary science, was intended from the start to be permanent, covering a broad field of science in the museum for a decade or more.

Such a project seems at first sight to call for a straightforward popularisation and mass media format, with didactics and science communication as the relevant framework. But the project turned out to be a much more challenging process of knowledge production. Of course the wishes of the different financial backers of the exhibition had to be fulfilled. But a museum is more than just an agency for communication: it has an educational claim within democratic society – to enable people to engage actively in the development of our science and technology based societies. The mere translation of the results of science from a disciplinary to a more popular language certainly will not be sufficient for this purpose. This became clear in the wider PUS debates of the 1990s when the need for a more thorough "Public Understanding of Research" (PUR) became obvious. The essence of PUR is to convey in addition sense of the *process* of research; to help understand its internal and external driving forces, its societal implications and in a way also to look behind the closed-up doors of the research labs at what the researchers are actually doing there (Chittenden et al., 2004). As the curatorial team at the Deutsches Museum took this claim seriously, it therefore became necessary to take a more reflective stance. Thus, it was obvious for example that the simple retelling and visualising of the founding myths of the nano-scientists defining their field certainly would not suffice.

In order to convey a deeper understanding of the multidimensional research processes in the nanosciences, the courage was needed to sketch both a grand picture of the field as well as to tell exemplary stories (or rather episodes, as Anke te Heesen coined them) from the field which would draw on a collection of artefacts. The question then was whether we would be able to profit from the rich epistemic potential of the exhibition format which the museological literature alleged. It would then be a "translating" exhibition in the productive, epistemic sense of the concept of translation – one which is alluded to so indicatively in the title of a current support program of the

German Federal Government for the humanities: "Übersetzungsfunktion der Geisteswissenschaften" ("translation function of the humanities").

All in all we faced a rather intractable, interdisciplinary task – and we all know that interdisciplinarity (especially in bridging C.P. Snows "two cultures") is difficult in real life, especially in a museum environment where the highly technical process of exhibition production needs to be taken into account at the same time. It is thus indispensable to profit from collaborations with external scholars. In our example we have been able to supplement our curatorial work with a research project funded by the Volkswagen Stiftung, "Knowledge Production on the Nanoscale", with both a historical and a sociological case study on nano-research in Munich. Starting with questions similar to those of the exhibition project, the investigation soon developed its own research dynamics.

Thus, our project initiated further scholarly work whilst at the same time drawing upon other research conducted elsewhere. However – and this will be my point in the following – the exhibition team also found its very own answers to questions which arose from struggling with the exhibition concept and the exhibition format.

Asking the appropriate questions

Before going into some detail and examples from our work, it is necessary to describe in short the conceptual framework of the exhibition. The original idea, inspired by the "Public Understanding of Research" approach, was to provide the visitor with an interdisciplinary tour through a broadly conceived landscape of nano and biotechnological research. We deliberately decided not to make an exhibition on nanotechnology – the difficulties of defining and demarcating the field seemed too obvious. But we started from the assumption that a more or less interlaced landscape of research disciplines on the nanoscale, covering parts of chemistry and physics as well as molecular biology, does exist. Thus, the tour had to enable a comprehension of the more and more interwoven research dynamics of the whole field.

This concept took the popular thesis of a convergence of the natural sciences in the era of nanoscience seriously, actually putting it on trial. We realised that we had a complex field to cover, and writing the storyboard raised questions such as:

Is there actually a nanoscale science, resp. what is common to all these nanosciences (or rather nanotechnologies)? The objects of research, the research methods used, or rather the science fiction which came with nano from the very beginnings?

Is there a new quality of interdisciplinarity emerging on the nanoscale? Do nano and bio gradually fuse or is their mutuality a mere coincidence of scale?

What are the origins of the field (and thus the historical perspective for a presentation in a museum)? What is new and in which respect? Do we see evolutionary or rather revolutionary developments, and where is the field heading to?

All these questions would, in themselves provide material for a number of STS studies, but as an exhibition maker you should not expect to receive your answers and blueprints for your exhibition from such studies (for one thing, you won't have time for them). However, we were able to profit from the currently flourishing field of such studies on nanotechnology. We finally came by many of our answers by working through the specific evidences of the exhibition format and its visual rhetoric, all within the process of composing our storyboard.

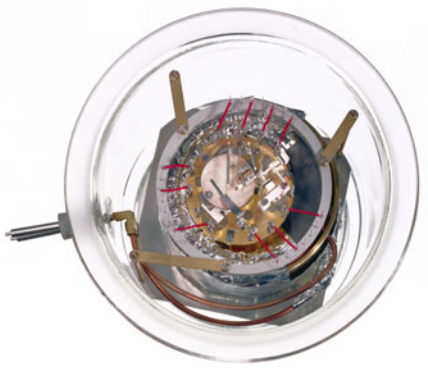
First, there were the artefacts we began to collect, e.g. scientific instruments from the labs, technological apparatuses for the production of nanoparticles or even market products with "nano inside". Thus, even for nano there are objects to see and to present. Secondly, there were the images

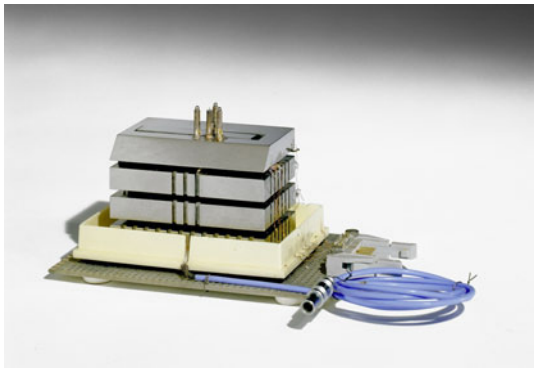
which current science (especially the nanosciences) produces so abundantly. And thirdly there was a specific *dispositiv* of our medium, the space to deploy the three-dimensional tableau of the exhibition. It was this imaginative space for scenographic experiments (described in storyboards) which put our more or less implicit or explicit hypotheses on trial. Thus, the storyboards were more than just textual and visual reformulations of the exhibition content, instead turning out to be a kind of analytical experimental set-up in themselves.

This approach is possibly somewhat specific for an exhibition which tries to encompass a complex research landscape. The consecutive storyboards we conceived tried to comprehend this landscape as a spatial topography and to put it into a coherent picture – a picture which had to draw on the evidence of the artefacts and images arranged there in ensembles. At this point scenography comes in a rather modest, restricted sense: It reduces to mere topography – which is perhaps bad dramaturgy but nevertheless a rich tool to arrange visual and spatial cross-references, correspondences and juxtapositions, neighbourhoods and alienations.

Some glimpses into our exhibition workshop

From objects to images: One focus of our work was to set up a collection of scanning tunneling microscopes, which fell into line with the existing museum collection of microscopes. This new research technology invented in the 1980s seemed to be at the heart of laboratory practice in the nanosciences and could possibly be seen as a sort of boundary object for the whole interdisciplinary field. The popular founding myth of the nano-scientists even claims this Nobel Prize winning invention to be the origin of nanotechnology. We thus started to collect instruments, precursors and bricolage gadgets as well as the first black-boxed commercial instruments and more advanced instruments specifically adapted to different sub-disciplines. Our work profited from recent scholarly work as well as from interviews conducted with some of the pioneers of this field in Germany[1].





Figures 1 and 2: Artefacts as evidence: Gerd Binnigs Nobel Prize winning first scanning tunneling microscope, a fragile prototype extremely difficult to handle, is directly juxtaposed to the brilliantly simplified instrument design which Karl Besocke at Jülich developed some years later. At a glance it becomes clear that not until now the very rapid and broad dissemination of the new research technology could start (photos from Deutsches Museum and Karl Besocke).

[1] Many thanks to Jochen Hennig, who had started his work on SPM imaging techniques at the Deutsches Museum and who later conducted these interviews for his PhD work in collaboration with the museum team.

When localizing this research technology within the topography of our exhibition we realised that our initial (and widespread) presumption did not work out. Our approach to embed the collection in a wider research context and, for example, to couple it to the molecular life sciences (which had already inspired the first nano-scientists) suggested putting this research technology into a somewhat different perspective.

Our scenographic concept actually provides a rather particular and prominent presentation format for all the nanoscale images we present throughout the whole exhibition. This implied new visual confrontations: the scanning probe images had to be seen now within a very broad range of nanoscale images. The direct comparison with images from other disciplines and techniques such as those from fluorescence microscopy showed less a common imagery of the nanosciences. Instead, a common perspective and interest became apparent: the focus on the local, the single, even contingent structure, some sort of local defect or specific spatial structure. Physicists and chemists are normally interested in regular or recurring phenomena and chemists traditionally do not use microscopes. However, with the emergence of nanosciences both now adopt an approach typical for the practice of the biological sciences.

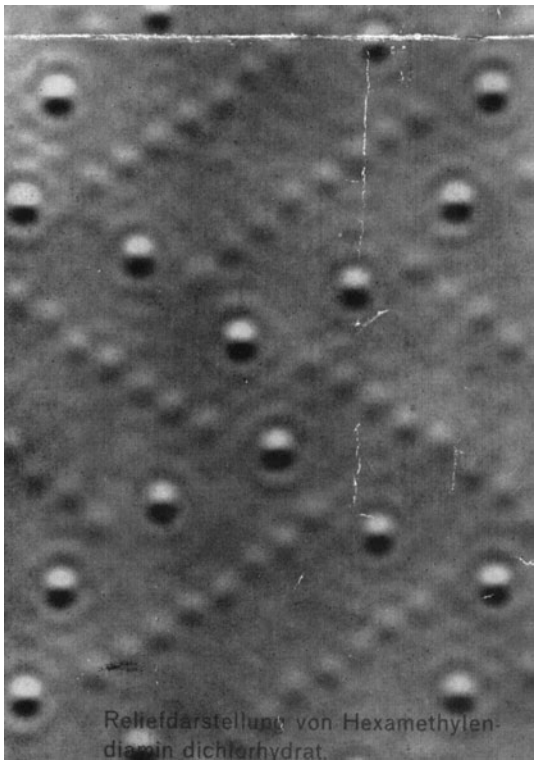
Similarly, we set up a collection of instruments from a research technology which undoubtedly has been of central importance for the molecular biosciences: DNA sequencing. This begins with the low tech apparatuses of the 1970s, covers several high-throughput sequencing robots of the 1990s and ends with more recent technologies explicitly triggered by nanotechnological methods. The aspect of mechanisation of the life sciences laboratory, which obviously manifests itself in our small collection (and which probably also helped connect the Life Sciences to the physical sciences) has up to now attracted little attention by historians of sciences; this is obviously a field that museums are challenged to address.

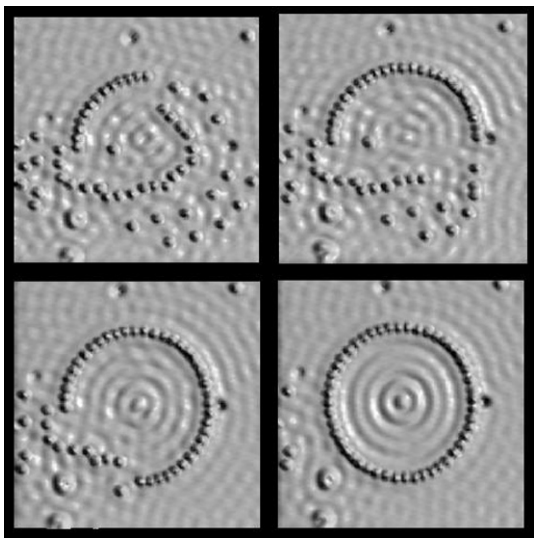
All this is rather typical curatorial work. Somewhat more of a curiosity for a museum is our collection of recent nanotechnological market products. With some 80 items it documents the first introductory stage of the technology in the market. This collection produced some surprises: some items have already and quickly disappeared from the market; for others, extensive enquiries were necessary to find out in which respect they are nano at all. In many cases companies are not of assistance when it comes to precisely describing an object for presentation in an exhibition. Fortunately we were able to take a closer look at some of them (at least, at their nanostructures) with our own scanning electron microscope. The collection with its very mundane products produced a sharp contrast in our storyboards – juxtaposed to the highly visionary discourses and imageries so characteristic for the nano field. In fact, the collection rather more reflected the very classic strands and technologies of the chemical industry.

Also, similar to a science lab, it is sometimes mere chance that provides assistance in a museum. We came up against a proper trouvaille in the museum collections, a so-called "photosommateur", an optical analogue calculator used in X-ray crystallography of the 1950s and 60s[2]. There we found striking images which amazingly anticipate the images we all know today from scanning probe microscopy but with a characteristic difference: this old crystallography technique is only able to reveal global periodic structures whereas the newer approaches depict the local structures. This was a further point where the exhibition project was able to give an incentive for further research. In any case it was amazing to see how a modern research technology – scanning probe microscopy – tied in with an old disciplinary tradition. Again, we became aware of disciplinary traditions which are still relevant for the field. These actually became more and more identifiable in later versions of the storyboard. This was in line with the results of the

[2] Many thanks to Hartmut Petzold, curator of the computer collections of the Deutsches Museum, who advised us of this forgotten instrument.

historical research project conducted on the Munich case by our colleagues of the accompanying research project.





Figures 3 and 4: Images as Evidence: Am image of a periodic crystal nanostructure made in the 1950s, long before nano, based on data from X-ray crystallography and "calculated" with a photosommateur. It is juxtaposed to the amazingly similar looking STM images of the making of a quantum corral done with a scanning tunneling microscope in 1993 at IBM. The difference highlighted here is that the former is a global, regular structure whereas the latter is a local, man-made structure (photo from sales prospectus, Archives of the Deutsches Museum, and IBM).

Topographies and "Raumbilder": It was through this continuing struggle with disciplinary shifts and strands, interrelationships and topographies that the epistemic productivity of the exhibition medium became most apparent. This was partly due to the fact that its central topic – nanotechnology – proved to be difficult to define and is the object of ongoing debates. All this questioning of the disciplinary topography of the nanosciences was somehow reflected in the exhibition topography, and all our storyboards could be in a sense understood as working hypotheses on this dilemma.

How did our storyboards work? First the storyboard organised the field and structured the exhibition space projecting the different topics onto a ground plan, a two-dimensional tableau. Even in this step surprising confrontations and intriguing dialogues between topics and objects appeared. Inscribed into this topography is a (more or less enforced) tour path – determining the perspective of the visitor and creating its individual visual dramaturgy. Then these structures are filled with all the concrete single objects and images: grouping and condensing them to local arrangements – sceneries – but also ordering and classifying them within a spectrum of the different formally defined presentation modes and thus introducing them into the global exhibition context. At the end of this process we often enough discarded the whole thing and started all over again. This is obviously an iterative process (also described in other papers presented at this conference), one which doesn't necessarily just work top-down and as analytically as described

here, but also bottom-up, in a more synthetic movement based on imagination and starting with single objects or possible object arrangements.

At the beginning our storyboards were characterised by the idea of an on-going dissolution of the boundaries between the multiple disciplines working on the nanoscale. This approach led to a star-like spatial structure, with a central staging of a "nano laboratory" area and with three single and linear presentation strands (covering physical, chemical and biological work) converging to this centre. The scenery in fact conformed to a well-known popular image of the field – but an image, which, as I argued above, had to be questioned. Later on we followed an approach which tried to somewhat disentangle the scientific from the technological perspective (a differentiation which has virtually disappeared in the popular use of the very notion of nanotechnology). The corresponding storyboards conceived a path which progressed from "observing" the nanoscale to "analyzing" and then "manipulating" it, with imaging techniques thus acquiring a central role as a sort of entrance portal to the nano-cosmos (and the exhibition). The techniques of manipulation at the end of the exhibition tour path then enabled a digression into the individual disciplines.

These ideas developed in line with our sketching of ever more complex exhibition landscapes, allowing for repeatedly new neighbourhoods and lines of sight between objects and topics, all of which were carefully considered. Not surprisingly, at the end of this process the concept proved too complex and overloaded with meanings and relationships; it asked too much of the medium – and of the future visitor. The overall picture of an exhibition has to be simple, as in science: it has to convey a clear-cut hypothesis.

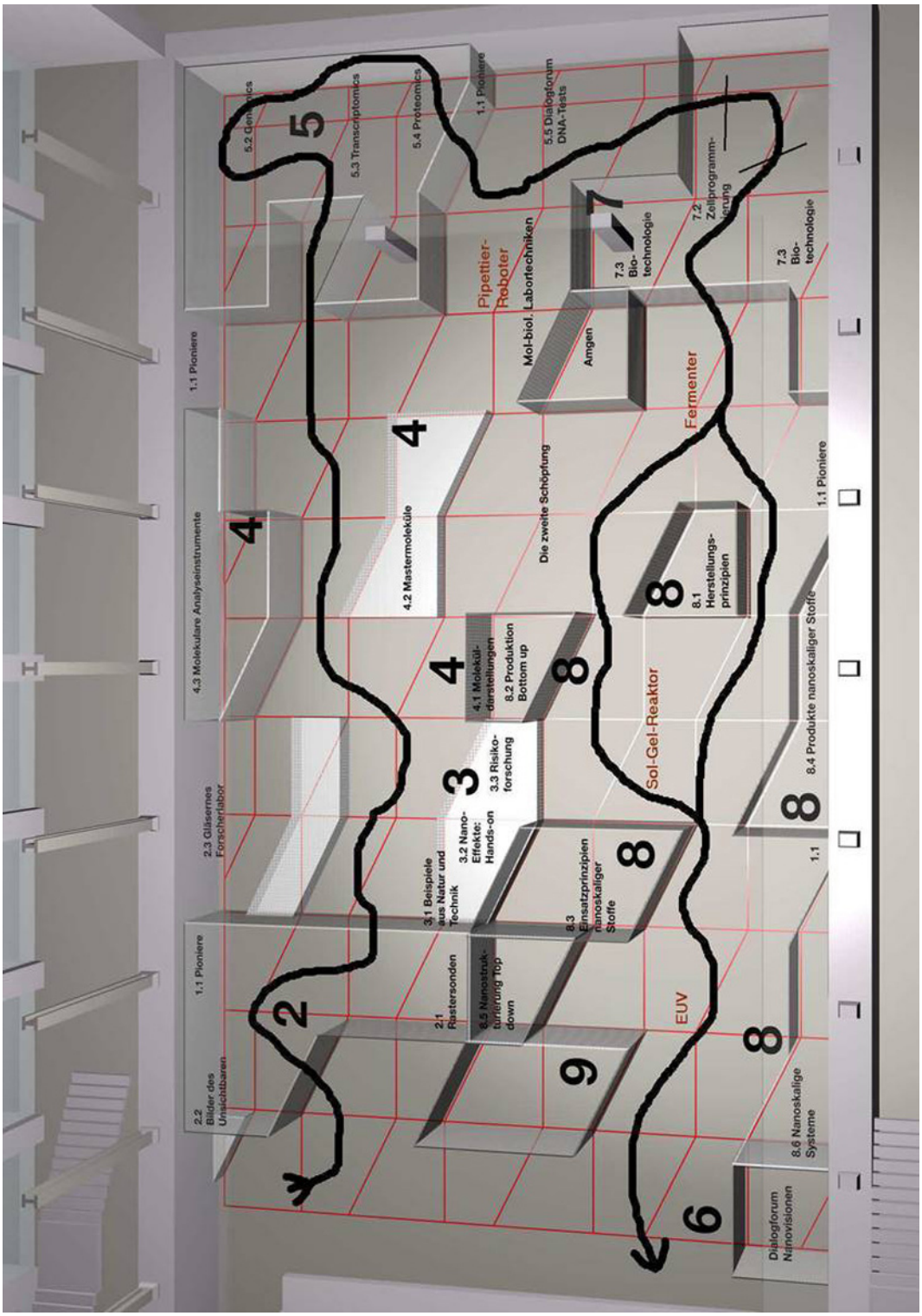
But, in filling up these landscapes and in arranging the objects, another "leitmotiv" finally emerged. Suddenly, a multifaceted interplay of nature versus technology seemed to lurk behind every corner of the exhibition, confronting the natural and the artificial, nature and technology, life and machine in continuously new variations. Now, the pieces of the puzzle fitted together and their common ground became clear: whether the biophysicist and creator of the first neurochip, the instrument builder in the STM lab, the physicists playing Lego with atoms and building funny gadgets, the synthetic biologist creating new bacteria or of the supramolecular chemist synthesizing his curious molecular architectures, they all were just the inventive creators and master-builders of their tiny little systems, species and prototypes, and they were all much more driven by their instinct for playing than by the epistemological claims of classical science[3]. The abundant imagery of nanoscale research, staging all these local, functional structures, fitted perfectly into that.

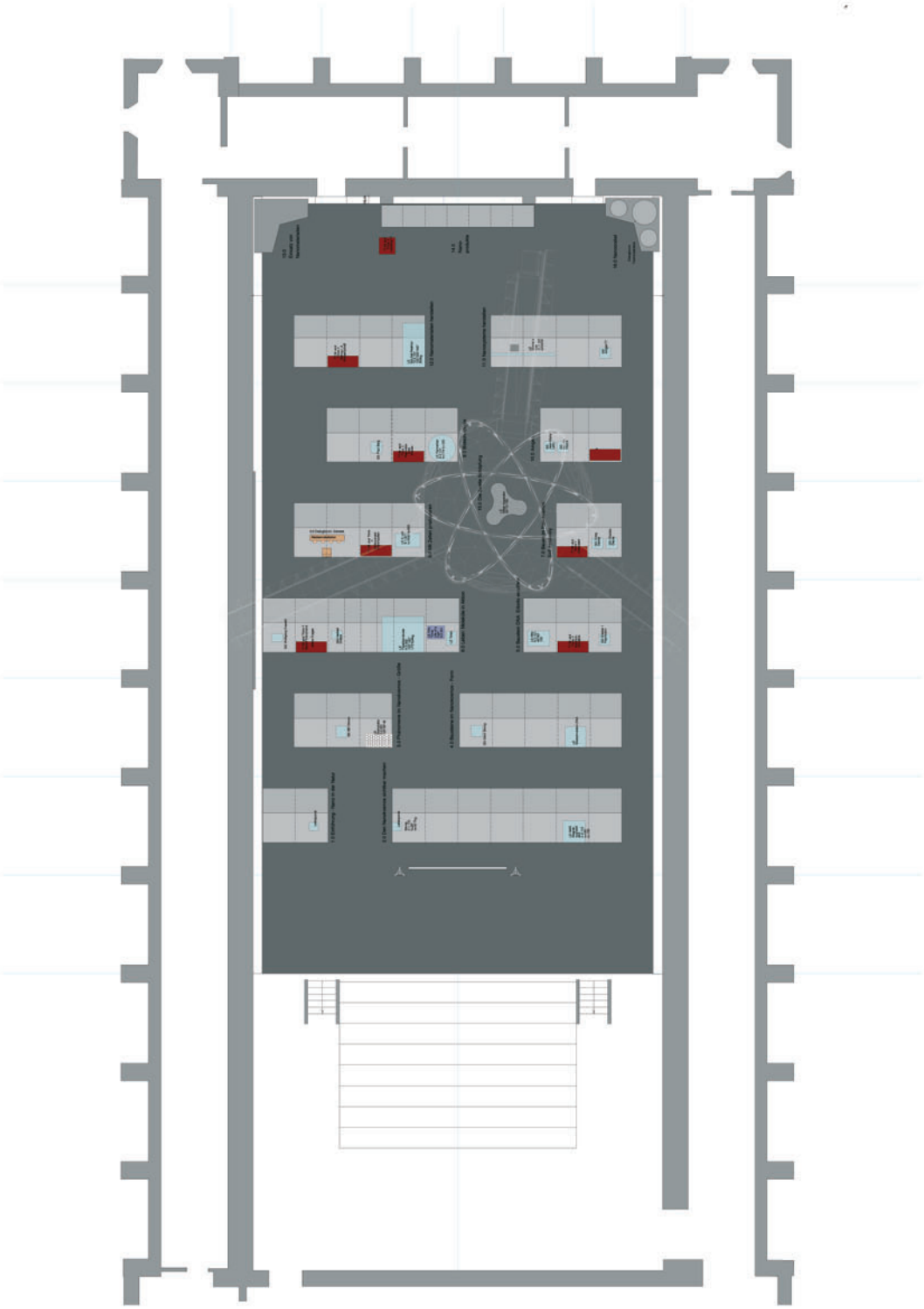
To be clear: notwithstanding the pervasive rhetoric of application used by nano-scientists, the nanoscale sciences are far from being an engineering science or simply application-driven. Most researchers do not intend to create things that leave the lab and work in real life; constructing nano-gadgets is their means to explore the new frontier of the nano-cosmos in their constructivist way. But the visionary potential of possible revolutionary applications in the distant future is obviously shining through.

It seemed appropriate then to take the ultimate visions of many nano-researchers of a "Second Genesis" as the pilot and focal point of our final exhibition structure. This was materialised in a central object arrangement with some lab objects from visionary research projects and a replica of the famous Miller apparatus representing the primordial soup of the "First Genesis" on Earth. This central staging of our final exhibition topography (supplemented by several audio dialogues

[3] This was perfectly in line with Peter Fromherz' self-assessment of his motivations for work, laid down in an interview conducted by Christian Kehrt und Peter Schüßler for the research project "Knowledge Production at the Nanoscale". The biophysicist Peter Fromherz is famous for having built a neurochip, an electrical interface of living cells and semiconductor chips.

between a fictitious lay person and a scientist) will hopefully get the visitors thinking about this first and second genesis, about nature and technology.





Figures 5 and 6: Struggling with topography: Several exhibition topographies were developed in an iterative process, conceiving and mapping the field of nano and biotechnological research in rather different ways. (Courtesy of Haslbeck. Ausstellungsprojekte).

Resumé

In this paper I have given a short glimpse into our thinking through an exhibition. Possibly my example is somewhat too specific. But the point is that the making of this exhibition – as idiosyncratic as it may be and very much unlike the model of a cultural history exhibition – was a productive knowledge experience. What we actually did was not just research information concerning various artefacts but to a large extent incorporated visual and associative thinking and also included "writing" fictions. Looking back on this experience one might even be tempted to compare the constructivist act of the exhibition makers, erecting exhibition landscapes in their scenographic lab, with the work of scientists building nano-gadgets in their labs.

It is not at all clear how all this exactly fits into academic scholarship. But natural sciences (and humanities) need perhaps more than ever to profit from this unique exhibition approach: an approach which is able to produce intelligible images (intelligible not only for the scholarly expert but for addressing a broader public), e.g. a form of knowledge which also allows a broad public to engage with – perhaps a sort of a more "socially robust" knowledge, to paraphrase a wording from another context. This is more than just top-down communication from academia to the public, providing instead a productive interface between the disciplinary expert cultures and society.

It is of course an open question whether the supposed communication to the public and our ambitious claims of a "Public Understanding of Research" will really work. We tackled this question as well, but this would be a story for another paper – a story from the same exhibition, which also generated some valuable research on informal learning processes in a museum.

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The Storyteller and the Altar. Museum Boerhaave and its Objects

Ad Maas

From time to time, as curator of Museum Boerhaave, you are expected to guide groups of people around the museum. These guided tours are often for schoolchildren, mostly of adolescent age. And as we all know, juveniles of adolescent age are not as a rule naturally inclined to appreciate a visit to a museum, let alone a classical "old-stuff" museum like Museum Boerhaave, the Dutch National Museum of the History of Science and Medicine. Their attitude – if anything – is one of a not very encouraging lack of interest and willingness. This comes as no surprise at all to me: I was once an adolescent myself. What strikes me more is that in the course of the tour – when I tell them about Van Leeuwenhoek's discovery of the sperm cell or when I explain to them how Willem Kolff managed to build the first artificial kidney during the years of the German occupation – they often start to become captivated: their scepticism turns to genuine interest. My stories are able to do what the instruments themselves cannot: to enchant people with a completely different mindset. Of course, living persons, like a guide, are better at captivating an audience than any other alternative, but the surprising attractiveness that the stories from the annals of science apparently have for visitors has always been something of an eye-opener to me. A museum like ours should not just exhibit instruments but also the story behind them. Museum Boerhaave is a rather object-oriented museum. Shouldn't we be paying more attention to the stories behind these objects? Shouldn't we be putting them into context?

In this paper – which is based more on day-to-day practical experience than a profound theoretical study – I will be arguing that the change from an object-oriented history-of-science museum to a contextualised approach in fact involves a changing view of the objects themselves: rather than regarding scientific instruments as showpieces, such a museum should treat them more as so-called 'key objects' (section 2). I will be discussing the consequences of such a changing view of objects for exhibiting them (section 3), for the research on them (section 4) and for their acquisition (section 5). I will, however, be starting by giving a brief outline of the historical background of Museum Boerhaave (section 1).

1. Instruments for the elite

To understand the museum as it is now, we have to go back in history. Museum Boerhaave was founded in 1927 by a group of professors and physicians with a fondness for scientific and medical instruments and a desire to preserve Dutch scientific heritage. Its first director was the physicist August Crommelin.

The academic world in Crommelin's day was a small community in which everybody knew everyone else and the founders of the museum were themselves part of it. First and foremost, the museum was a place for a learned elite of natural scientists and physicians: the happy few capable of appreciating the historical scientific and medical instruments. Crommelin's museum was an institute of modest size, which did however have a certain relevance for Dutch society simply because the scientists and physicians who endorsed it belonged to its leading, influential classes.[1]

[1] Maas, A., "Crommelins elitaire instrumenten," *Nederlands Tijdschrift voor Natuurkunde* 73 (2007): 184-187; *75 jaar Museum Boerhaave* (Leiden: Museum Boerhaave, 2006).

It is important to emphasise that Crommelin's museum did not have a more educational mission like the Deutsches Museum and the Science Museum in London for example; it did not aim to explain science and its role in society. This difference in mission continues to this day.

At the same time, some of the old elitism is still visible. In spite of current trends towards accessible, science-centre kinds of infotainment, Museum Boerhaave has remained a museum in which the scientific instrument – difficult or not – takes centre stage. In the words of its previous director, Museum Boerhaave should be 'an altar for the object'. In fact, this highly object-oriented approach would have been very suitable for 'Crommelin-like' audiences: those acquainted with both the Dutch history of science and scientific instruments.

It is clear that in order to be a relevant institution in society today we can no longer depend on a small academic elite. Firstly, we need to attract wider, less expert audiences – such as adolescent school youth. Secondly, the relevance of our museum increasingly, in my view, rests on the fact that, by displaying the feats of Dutch scientists and physicians, we are showing part of Dutch cultural history. We are contributing – to put it somewhat sweepingly – to the Dutch national identity: a hotly debated topic in current public discourse. Both aspects imply that there is a gap to bridge. A bridge needs to be constructed from the object to the less-informed audiences to express its cultural dimension. Therefore, the object has to be taken away from the altar. Rather than an altar, it needs a storyteller.

Figure 1: Telescope room in 1938 (courtesy of Museum Boerhaave, Leiden).

2. Showpieces and key objects

The approach of the storyteller (who, as will become clear, must be regarded as a metaphor for the historical context that can be added to the object, see next section) and that of the altar embody a different appreciation of scientific objects. Basically, the object-on-the-altar emphasises the intrinsic qualities of the objects: their aesthetic and their artistic qualities. They are showpieces, since they are beautiful, artfully or ingeniously made, or maybe cult. They are, in short, attractive. The storyteller on the other hand regards an instrument as a so-called key object – as the 'key' to

the story behind it, rather than as an object with intrinsic value.[2] So the change from altar to storyteller implies a shift from regarding objects as showpieces to regarding them as key objects.

In the extreme case, treating objects as key objects would mean that their intrinsic qualities were of no concern for the value you attach to them – whether, for example, they are displayed or not.[3] I would not like to adopt such a radical position. Of course, you would also like to collect and display objects that are simply wonderful to look at, such as our Auzoux models (Figure 2). For simple pragmatic reasons the ideal object is both attractive and has an interesting story to tell. Yet, if we look at the most important objects in the Museum Boerhaave collection, we have to conclude that the majority of them are top items because of the story they represent (even if some people might see the attractiveness of instruments such as that in Figure 7). This makes Museum Boerhaave a different kind of institution from – say – a design museum or an art museum. To quote, in summary, a colleague of mine: 'scientific instruments are no works of art'. For the most part they should be considered as key objects.

In the remainder of this paper I will be investigating the consequences of a shift from showpieces to key objects for, first, presentation, then for research, and finally for acquisition – the three categories of activity of a Museum Boerhaave curator in which objects are involved.

Figure 2: Auzoux model of a head (courtesy of Museum Boerhaave, Leiden).

[2] for this classification: Allart, B., "Utrechtse universitaire historische collecties in onderwijs en onderzoek: een pilot van gebruik van collecties in de praktijk." *Gewina* 30 (2007): 182-193.

[3] cf. Allard, "Utrechtse universitaire historische collecties in onderwijs en onderzoek."

3. Presentation

Figures 3 and 4 show scientific objects on display in Museum Boerhaave, presented in a classical manner as showpieces, almost like works of art. In my view they are displayed in a pure and honest manner, but also without much context. It is up to the visitor to rate their value; there is no central story to take them by the hand and tell them what they should see.

Figure 5 is an image of a room largely devoted to Heike Kamerlingh Onnes, the Nobel Prize-winning physicist who built a world-leading low-temperature laboratory where helium was liquefied for the first time and where superconductivity for instance was discovered. Not only are the objects displayed almost without context, but also no effort is made to demonstrate their mutual relationship, even though they used to be interconnected and together formed a single apparatus. The theme of the room is vaguely described as 'modern physics'. Apart from the Kamerlingh Onnes instruments, objects associated with other great Dutch physicists of his day are also displayed in this room (the decades around 1900 are known as the 'Second Golden Age' of Dutch science). Additionally, there are showcases full of fine but anonymous laboratory instruments (not visible in Figure 5). It very much depends on the visitor's background, knowledge and interests as to which objects will appeal to them and why they will appeal to them.

It is important to resist the impression one might have that Museum Boerhaave is merely a loose collection of scientific instruments presented as showpieces. From the outset, the museum was among other things meant to honour Dutch scientific achievements of the past and consequently had an important cultural-historical component. Van Leeuwenhoek's microscopes for instance – which have always been considered to be among the museum's most valuable assets – above all represent a piece of Dutch cultural history, rather than a tool with magnificent intrinsic qualities. In addition, a development has already taken place in which science has gradually and unconsciously been presented more in its cultural setting. The whole museum – which in its current location opened its doors in the early 1990s – is even largely furnished along the lines of Dutch cultural history: there is a room for the so-called Golden Age of the Dutch Republic, another for the Enlightenment era, etc. Yet, these themes are only vaguely expressed in the rooms; the bias is still very much towards the 'object on the altar'.

To display scientific instruments as key objects, they need to be firmly embedded in a context. After all, by themselves instruments do not reveal much of the drama behind them. This context firstly involves a compelling story line to present the instrument as part of a historical epoch or development. The story line can also be instrumental in the selection of objects for display (in the museum as it is now objects are apparently often chosen purely for their attractiveness or historical significance, regardless of their relationship with other objects in the room). Secondly, you need additional layers of information, such as related non-scientific objects and attributes, animations, games, sound samples, and film and photographic material. The latter may include images of the environment in which the instrument was used, of people associated with it and of observations made by it. All this should be brought together in a suggestive manner as a function of the story line. Thirdly, but not unimportantly in Museum Boerhaave's case, using more contextual material implies that you will need fewer scientific instruments in your exhibition room.

It is important to note, at this point, that storytelling should not be taken too literally, as a text with a story attached to an object. My storyteller can also 'speak' through images and animations, and even through a suggestive composition of related objects or by creating an atmosphere. My storyteller is a metaphor.

Figure 3: 's Gravesande – Van Musschenbroek collection (room 4), (courtesy of Museum Boerhaave, Leiden).

Figure 4: 18th-century microscopy (room 6), (courtesy of Museum Boerhaave, Leiden).

In our Quest for Absolute Zero exhibition (from 10 July 2008 to 10 May 2009) we have deliberately chosen to deploy the key object approach. We created a context by using such devices as animations, games, film fragments, photographic blow-ups, spoken text and a powerful design (see figure 6). Our compelling story line was indeed: The Quest for Absolute Zero, one of the most adventurous episodes in modern science, including a large measure of human drama and an important role for Dutch physicists. The way our objects were involved in this story determined their historical significance. We took the visitor by the hand in a way that is different from the non-committal presentation of the current permanent exhibition, but one that we think is appropriate for wider, modern audiences.

Doesn't all this attention to context, to image, sound and moving elements, distract from the objects themselves, the *raison d'être* of the museum after all? On the contrary, I would say. Take the Kamerlingh Onnes helium liquefactor (figure 7). If this were simply an isolated object on an altar, you could write on its showcase text that it is the instrument in which helium was liquefied for the first time at a record cold of 4K. I think this information will only make the visitor partly aware of its significance. The visitor will have a different view of the object if it is displayed as the absolute climax of a decades-long international competition between physicists, during which reputations were made and broken. And if the visitor could learn of Kamerlingh Onnes' efforts, the many years of hard work, his cleverness and his perseverance – which all lie 'behind' this apparatus – then their awareness of its historical significance will only be enhanced. The one thing we have to ensure is not to let the object be overpowered by too glaring a design, which is a delicate balancing act indeed.

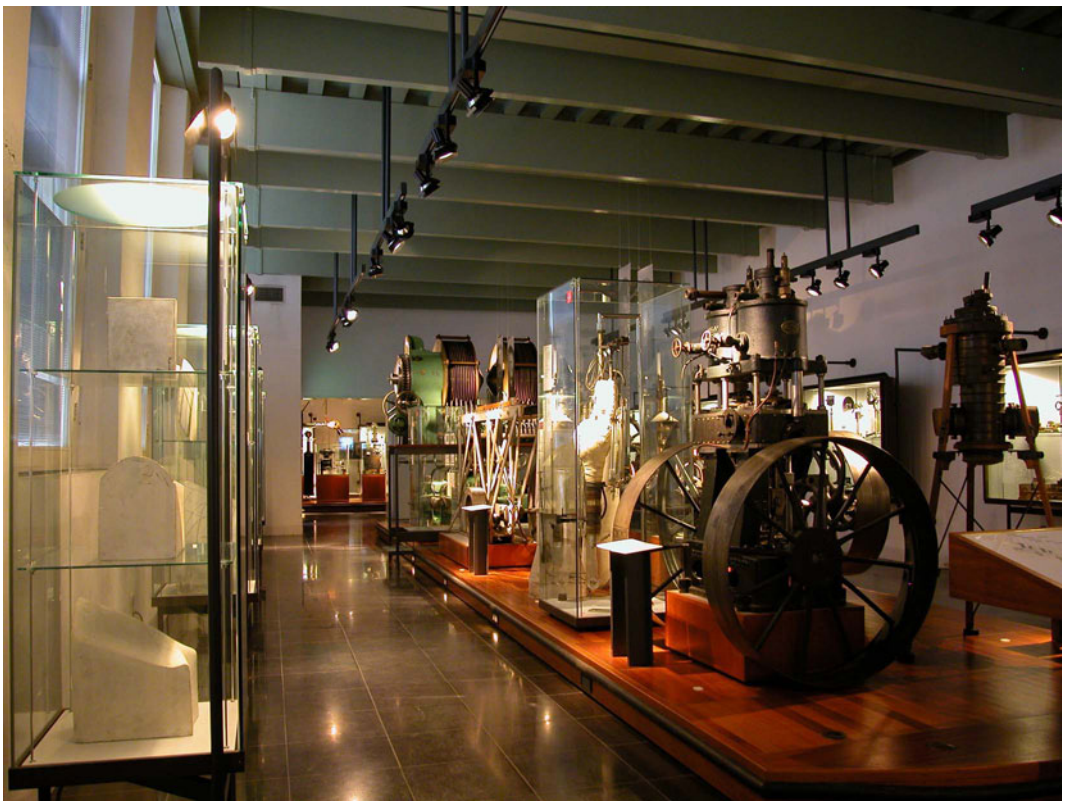

Figure 5: Modern physics room (room 21), (courtesy of Museum Boerhaave, Leiden).

Figure 6: Impression of The Quest for Absolute Zero (courtesy of Museum Boerhaave, Leiden).

Figure 7: Kamerlingh Onnes helium liquefactor (courtesy of Museum Boerhaave, Leiden).

4. Research

Regarding collection items as key objects rather than showpieces also implies a different focus for the curator's research activities. Just as in the case of presentation, an unconscious shift towards the key object approach is already under way.

First, to go back to the old days once more: in the early decades curators used to be scientists with a love of historical scientific instruments. They often knew all the ins and outs of the instruments, having often worked with them for many years themselves. Their research resulted in studies such as *Microscopium*, a standard work on historical microscopes by the second director of the museum, Maria Rooseboom, who had herself been a biologist.[4] The early generations of curators often worried about the functioning of scientific instruments (Crommelin for instance conducted technical studies into Nobert's diffraction gratings and Huygens's pendulum clocks[5] and had a particular interest in collections of scientific instruments).

Nowadays, this type of curator has been replaced by more or less professionally trained historians of science, who have not had a career as natural scientists and who have sometimes not even had any scientific training at all. Their relationship to scientific instruments is different from that of the earliest generations of curators, as they are inclined to consider social and cultural aspects more closely. The current generation of curators often looks for the story behind an instrument, the cultural context in which it functioned, its user. A good example is my own study of Einstein's *Maschinchen*, an instrument that, in my view, is more interesting from the human-interest point of view than from its place in the history of scientific instruments.[6] Regarding objects as key objects is not only appropriate in addressing modern audiences; it is also in line with the interests of modern curators.

The growing emphasis on cultural and social history and human aspects definitely comes at a price. Traditional connoisseurship has to some extent been disappearing amongst the ranks of curators. Our focus on collections is also tending to diminish. Currently, we are even discussing the way we produce catalogues of our major collections. We have published such catalogues of our microscopes, our telescopes, our clocks, etc,[7] but it is felt that we may do better shifting the focus to a more contextual, organic way of studying collections, which for example describes scientific objects of a certain epoch. Shouldn't we, rather than cataloguing galvanometers or spectroscopes, be better meeting our social task by writing such culturally embedded products? Shouldn't we better spend our time writing 'stories' that can be published (or presented in different ways by making use of modern media, such as blogs, films or animations) for wider audiences and, in consequence, underlining our relevance as a museum that creates (national) historical culture?

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[4] Rooseboom, M., *Microscopium* (Leiden: Rijksmuseum voor de Geschiedenis van de Natuurwetenschappen, 1956).

[5] Crommelin, C.A., "Over tralieplaatjes van Nobert ter beproeving van microscopische objectieven en ter demonstratie van interferentiekleuren," *Nederlands Tijdschrift voor Natuurkunde* 1 (1934): 305-320; id., "Pendulum cylindricum trichordon van Christiaan Huygens," *Nederlands Tijdschrift voor Natuurkunde* 5 (1938): 314-318.

[6] Maas, A., "Einstein as Engineer: The Case of the Little Machine," *Physics in Perspective* 9 (2007a): 305-328.

[7] Fournier, M., *Early microscopes: A Descriptive Catalogue* (Leiden: Museum Boerhaave, 2003); Zuidervaart, H.J., *Telescopes from Leiden Observatory and Other Collections 1656-1859: A Descriptive Catalogue* (Leiden: Museum Boerhaave, 2007); Hooijmaijers, H., *Telling Time: Devices for Time Measurement in Museum Boerhaave: A Descriptive Catalogue* (Leiden: Museum Boerhaave, 2005).

5. Acquisitions

We could also further develop the idea of the key object in the field of acquisitions. Ten years ago, we acquired a large collection of chemical instruments from the Royal Dutch Chemical Society (*Koninklijke Nederlandse Chemische Vereniging*): anonymous and unrelated pieces and as it happens mostly not particularly attractive either. We took them because they were types of instruments we did not have. Seen from the key object perspective this was a pointless acquisition. The objects are a key to (almost) nothing.

From the key object perspective, a museum does not collect instruments, but a piece of scientific or cultural history. This means that an acquisition often inherently includes photographic material, documentation, interviews, etc. At the moment I am working on the acquisition of a collection of instruments from the research laboratory of the Anglo-Dutch multinational Unilever. The instruments themselves are not very exciting, yet the reason we are taking them is that they represent the story of one of the most famous Dutch industrial research labs, where research is in particular conducted on margarine and washing powder. I am consequently selecting such instruments as colorimeters and penetrometers (for testing the hardness of margarine) and excluding all kinds of pH meters and voltmeters that do not express the particular Unilever identity, even if we do not have such types of instruments in our collection. At the same time, I am also considering historical studies and photographic material, and I have written down the recollections of a retired Unilever research lab employee. These additional materials and information can give the instruments their meaning. In particular, presenting and collecting modern science, with its bulk-produced, unattractive and 'ununderstandable' black boxes, is simply impossible if scientific instruments are regarded as showpieces.

Again, I would not like to argue that we should exclude objects that are simply attractive but have no story to tell. Of course, we will also admit pieces for aesthetic reasons. What we should get rid of, however, is 'stamp collecting' – admitting every different variation of a type of instrument simply because we do not yet have it in the collection. This is also especially relevant for modern times with the bulk of mass-produced instruments.

6. Conclusion

The change from regarding objects as showpieces to key objects elaborates on a historical development that has already been taking place, in which objects have been unconsciously regarded more as such. In this paper, I have argued for a more consistent (though at the same time pragmatic) enforcement of the concept. The difference between the showpieces and key objects approach could be summarised as follows:

	Showpieces	Key pieces
Emphasis	'Intrinsic' qualities, attractiveness	Story behind the object
Endorsement	Small, socially influential group of connoisseurs	Society at large
Presentation	Single, 'isolated' pieces	In a context
Research	The working of the object/catalogues of collections	The human and cultural 'story' behind the object
Acquisition	Objects, 'stamp collecting'	Objects, documentation, images, narratives

The final question is whether the suggested showpieces/key object transformation merely applies to the particular situation of Museum Boerhaave or whether it also addresses developments of a more general nature. On the one hand, as I mentioned above, Museum Boerhaave is an institute with a rather singular history and mission, and with a 'difficult' collection to present to non-expert audiences (a museum of technology or a natural history museum can perhaps rely more on the accessibility of their collections). On the other hand, there are also elements that refer to more general developments. One such development is that historians of science are increasingly focusing on the social and cultural aspects of scientific practice; in fact, objects have in recent times been interpreted as entities to which different meanings can be given and that can have a 'biography' or a 'career' (see for example: Alberti 2005). Next, we can see that modern museum visitors are calling for more context, more 'movement', more 'experience', rather than serenely displayed objects. At the same time, a decreasing number of people (visitors) have worked with classical scientific instruments and know, from their own experience, how to appreciate them. Also, looking for national identity in national history in our globalising world is not limited to the Netherlands. These developments might suggest that the transformation I have described here might partly have a wider implication.

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Old Answers, New Questions – What Do Exhibitions Really Generate?

Ulrich Raulff

About a year ago I started writing an essay on a strange byway of German literary history. My subject was a curious collection of sculptures. The *George-Kreis*, i. e. the circle gathering around the poet Stefan George (1868-1933), had left it behind. It was an amazing mass of wood, plaster, stone and bronze heads, nearly 100 percent of them representing male human beings. With the exception of "the Master", Stefan George himself, nearly all were young, and easily identified as Max K., Ernst G. or Fritz W. As representations of individuals each of them had to look different, as representations of a circle, a kind of brotherhood, each should bear a resemblance to each other: Therefore, a strange spell of similarity was cast over the assembly. All of the depicted persons looked solemnly, no one smiled or laughed and tossed his head. We put together a show of almost 200 heads most of them coming from our own collections and complemented by some 40 or 50 loans. We guess that this was about half of what once had existed.

The essay I wrote helped me to understand the phenomenon of a poet's circle that left behind an enormous end moraine of bronze and plaster. I had done some research into its intellectual origins and literary context. Now, in the process of writing, ideas came to the surface, and loose pieces fell into their places. Questions I often had asked myself before eventually got their answers. I saw clearer now how close the production of these sculptures had been connected to a certain reading of Plato which George had initiated two or three years earlier. I felt the euphoria of the historian who thinks he *understands*. All this happened a couple of months before we actually began to set up the exhibition of the sculptures.

It had not been easy to find what curators use to call the *room image*. Spectacular as the mass of heads was – reminding some visitors of the Chinese emperor's clay army – it confronted us with intricate questions concerning the way of presenting it. I had dreamed of a circular piece of display architecture with the heads arranged on bookshelves like sculls in old bone houses or *ossuaires,* which you may find near 19th century battlefields. But the structure didn't fit in with our museum, and since not all of the massive heads had a metal spine or hook to be properly fixed on the shelves they would have been a mortal danger to our visitors.

Our designers had different ideas. They were fascinated by the battered charm of the material and tried to persuade us to create a mock archaeological site. Had we asked the grandchildren of the members of the George Kreis, they would certainly have insisted on showing the sublime objects on individual pedestals like the heads of roman emperors in some princely gardens. But we didn't ask them. Nor did we listen to our designers.

We kept searching for the most simple and most apt solution. And one morning we got it. We commissioned an enormous black table to be constructed, a piece of furniture that looked like a very big altar or a mass stele. It was 12 meters long, 6 meters wide, and 75 centimeters high – large enough to carry all 200 heads, those without plinths resting on their sides, the others standing upright. The edges of the table contained flat glass showcases set into the surface and presenting a selection of documents, autographs, books, and photographs.

The overall picture of the heads, the *room image*, was of extreme simplicity, and it was impressive at the same time. But more amazing was what one might call its *epistemic effect*: It confronted us with new questions concerning the very nature of the phenomenon we were going to expose. There were questions about its poetic meaning and its practical use. There were questions

about its relations to categories such as beauty and the sublime. We would never have asked these questions had we not put the sculptures in exactly that order. On that table. In that room.

Since that day I know what exhibitions really produce: They bring up problems. They ask questions. Questions you would never fall upon when doing your philological job, writing papers and reading books. The simple reason for this is that the objects on display are material objects, put together in juxtaposition or in any other spatial order. They are not just objects of *ekphrasis*; they haven't been reduced to mere descriptions. They haven't been flattened down to print lines. They still possessed their full expressiveness, their aesthetic power.

Figure 1: Exhibition Das geheime Deutschland. Eine Ausgrabung / The secret Germany. An Excavation (courtesy of DLA Marbach; photo: Chris Korner).

Research in the museum has become a fashionable subject these days. I don't know *why*, I just observe it. You look on your writing desk, and there are invitations to colloquia on research in the museum all over Europe. You find always the same people invited to listen, and the same people to talk. The colloquium at the Deutsches Museum is different. It doesn't repeat the museum question, it brings up the exhibition question. That's a difference. You know what a museum is, you know what exhibitions do. You know ICOM, the International Council of Museums. ICOM gathers all information on museums and distributes it among its members. One of ICOM's publications is a booklet called *Standards for museums* ("Standards für Museen", 2. edition in 2006). Topic no. 7 is entitled "Forschen und Dokumentieren", research and documentation. Research, the ICOM manual says, has to be published what is mostly done by means of the *wissenschaftliche Bestandskatalog*, the scientific catalogue of holdings. And then the booklet says: „Auch Ausstellungen vermitteln wissenschaftliche Erkenntnisse…" (*also* exhibitions present scientific insight).

There is no better means to explain what *Old School* means in the museological field. Central to that message is the word *auch* or also. And that is why the difference between research in the museum and research by exhibitions really matters. A New School in museology has emerged in

recent years that simply denies the word *auch*. If it is the museum that produces scientific *Bestandskataloge*, it's the exhibition that produces the problems and that asks questions.

In the beginning Marbach was a museum. The Schiller-Museum, inaugurated in 1903, was conceived as the *Pantheon des schwäbischen Geistes*, as a temple of the Suebian mind and art. But from its beginnings it did not restrict itself to just *showing* the documents of that *Geist*; it also began to collect autographs and books. So the museum comprised also an archive and a library. The three institutions grew simultaneously until in 1955 the German Literary Archive was founded – from within the museum.

Since that time things have changed, now the tail wagged the dog. The museum was considered to be the show window of the archive. The archive became the proper research centre or Think Tank of the institution, while the museum found itself confined to the state of a medium of mere communication with the public.

There were other reasons, too, for this secondary state of the museum. One of them was the predominant idea of literature and literary reception. Literature, after all, was defined as an invisible phenomenon. It happened between the author's mind and the recipient's mind. It was the reading eye that secured the transfer between these two minds – not the eye of the beholder. All the elements of the visible world with the exception of printed letters were considered as mere makeshift. To exhibit whatever traces were left of the creative processes of literature or the memorabilia of its authors – letters, journals, broken glasses, stains of ink and cigarettes, X-rays of a chest or a cheque signed with kisses – were nothing but incitations to go back to the real thing: *the literary text*. Objects in a literary museum were only good for taking people back to reading. Exhibitions were regarded as detours to reading.

When in recent years we created a new museum – fifty years after the foundation of the Deutsches Literaturarchiv – we thought time was ripe for a reappraisal. We thought we should move backwards, closer to our origins, and think of the museum as a reflecting and researching institution on its own. We began to regard exhibitions as integral parts of research processes: they were no longer mere presentations or representations of what had been conceived elsewhere. We tried to forget everything we knew about literature, its circulation and its ontological whereabouts in the world. We started to confuse the difference between the eye of the beholder and the eye of the reader. We stopped to distinguish aesthetic and epistemic processes. After all our *heros eponymos* was a man called Friedrich Schiller.

Figure 2: Exhibition Ordnung. Eine unendliche Geschichte / Order. An endless Story (courtesy of DLA Marbach; photo: Mathias Michaelis).

In 2007 and 2008 we did a series of exhibitions that went along with intensive (and sometimes extensive) research. I mention five examples. Three of them were "monographical" exhibitions. They had to do with one single author or, as in the case of George, a group or circle of authors. In the remaining two we tried our hand at more general or structural themes starting from a singular notion or a historical problem and diving deep into the archive's holdings, looking for material that might help us sharpening our notions and clearing the intentions of our search. This was the case when we were preparing a quite large exhibition on the notion of *order* that finally opened in the summer of 2007. *Ordnung. Eine unendliche Geschichte*, Order. An endless Story, dealt with techniques and patterns of order in literature and in all creative processes that finally lead to written texts. All we had in the beginning was the light suspicion that *order* is deeply misconceived if you see it only as the opposite term to *creation* (tending always and for intrinsic reasons to the side of *chaos*). Order or rather techniques of ordering accompany the creative process, and sometimes are generic to it.

With this idea – no more than a dim searchlight – we entered the archive and proceeded to a deep search within about 200 different holdings (of about 1200 estates that we possess altogether). Our search being closely followed by a process of ordering and comparing, we tested provisional notions and dropped them. The final outcome was a show of about 230 objects, mostly but not exclusively of pencil, ink, and paper. They fell into 8 categories of order ranging from the most external techniques like wrapping up, gluing and binding together to the most intrinsic and subliminal operations of order like minimal corrections in the rhythm of a poem. The exhibition was accompanied by a catalogue consisting of three general essays on the subject and about 100 short but detailed descriptions of singular objects. These miniature essays were written by both curators and a group of about ten colleagues, scholars and librarians, from both museum and archive.

The following three exhibitions were author-centered and carried a more or less famous name in their title. The first one presented the so-called *Brunnenhefte* which Robert Gernhardt, a famous poet, humorist and draughtsman, who died in June 2006, had left behind. *Brunnen* (fountain) is the brand name of a German company producing writing materials for school and office. *Brunnenhefte* therefore are exercise books for pupils. Robert Gernhardt used them in an uninterrupted stream of verse making, writing and drawing over a period of 30 years, and he finally left a total of 720 exercise books: they actually are the fountain of his genius. The problem with Gernhardt's *Brunnehefte* was not to give an overall survey of his themes and subjects, a kind of repertoire that helped making the exhibition as well as a forthcoming edition of his Collected Works.

The problem was – as with Stefan George – how to show the Brunnenhefte in an exhibition, how to present them without nailing them to the wall or sinking them in glass coffins: both ways would have made them disappear. Despite their mass and their intrinsic comic value they are inconspicuous objects, comparable to a swarm of birds rather than to a cage of lions. This is why we finally presented them in a "flying" order: a long trail of hanging double glass panes, arranged in a serpentine gently swinging from one room to the other. As Robert Gernhardt always and exclusively used pencils of the cheapest kind, Biros or Bics, we had a swarm of those bics hanging from the ceiling of the room where the trail began. None of our visitors told us that this delicate image was too much *Inszenierung*, staging.

Figure 3: Exhibition Kippfiguren: Robert Gernhardts 'Brunnen'-Hefte / Robert Gernhardt's 'Brunnen'-Notebooks (courtesy of DLA Marbach, photo: Chris Korner).

I skip the George exhibition, which followed Robert Gernhardt as you already know it. After that we realized an exhibition of works and documents by the late W. G. Sebald. We had acquired Sebald's archive three years after his sudden death in a car accident in 2001. Now we were going to present it for the first time to the public.

Again it took us months to find the most apt and simple way of giving an insight into his sophisticated way of interweaving texts and apparently corresponding photographs. We finally

invented a sort of literary plantation with a strong accent on verticality. The visitor could experience how certain passages of his four great "novels", from *The Emigrants* to *Austerlitz*, almost *grow* like plants out of a humus of images – i.e. postcards, objects, maps, and drawings – and, needless to say, of other literary texts by Goethe, Stifter, Kafka, and Adorno. We thus have tried to reproduce the complex and playful genesis of Sebald's texts out of a stream of other literary particles, images and mnemonic signs. You may well imagine that the two curators of the exhibition spent months in the catacombs of Sebald's archive in order to understand his complex way of thinking by analogy and his image-based philology.

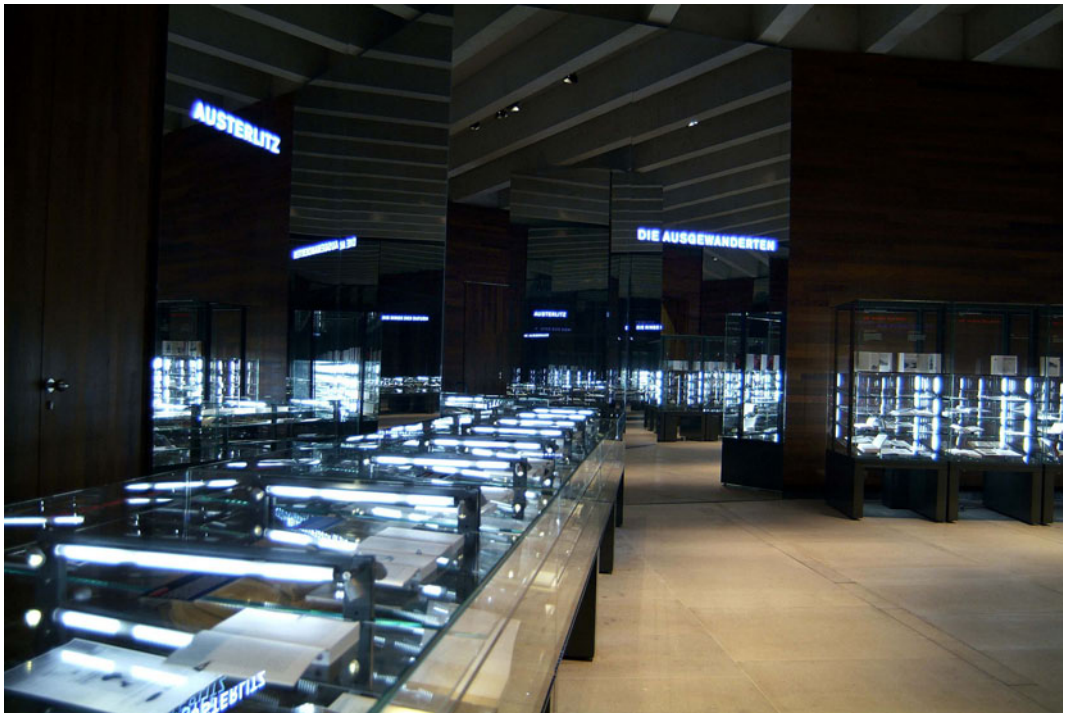

Figure 4: Exhibition Wandernde Schatten. W.G. Sebalds Unterwelt. / Wandering Shadows. W. G. Sebald's Underworld (courtesy of DLA Marbach, photo: Chris Korner).

One of the godfathers of this exhibition was Kurt W. Forster, a famous historian of art and founding director of the Getty Research Centre at Santa Monica. I know him since the eighties, and when I met him three years ago our conversation quickly turned to Sebald. He knew that we held his estate and was curious to see it. Being an experienced historian of photography and collage technique he was deeply interested in Sebald's use of photographic images as integral parts of his novels. I invited him to Marbach, and – surprise, surprise! – Kurt came. He stayed for a week, and from the first glimpse he was fascinated by Sebald's archive. But when he finally left our magic mountain, it was not with a theory about Sebald's iconography, but with some fascinating findings about Sebald's use of correspondence with his friends and readers. During the whole process of elaborating the exhibition Kurt Forster gave us his advice, he wrote an essay for the catalogue and he gave the opening address.

Why do I tell this? Because it may help to demonstrate that the research processes accompanying our exhibitions do involve people, places, and ideas that transcend Marbach by far and large. Last week we went through some 50 applications for scholarships – we give them to post-doc, graduate and even undergraduate students. One application came from Argentina. The student asked for financial help for a two month's research into the relationship between W. G. Sebald and Borges. She ended her application by saying that she would appreciate being invited as soon as possible so

that she could see the exhibition. Another applicant asking for help to study the relation between literature and sculpture told us she had visited the George exhibition twice. My assistant at that exhibition, its second curator, is now busy writing his Ph.D. thesis on the art of ekphrasis in the George circle.

Our most recent exhibition, opened only a week ago, again turns away from the GAS, the Great Author Show, towards a more systematic and extremely research-oriented subject. *Radiations. Literature and the Atomic bomb* detects the fractures and fissions within the genres of literature and philosophy from the summer 1945 up to the middle of the sixties when poetry tends to protest lyrics, and literature to *engagement*. A deep and minute research in the holdings of our archive unearthed a number of hitherto unknown texts (sometimes by famous writers), fascinating correspondences between Hannah Arendt and the young Hans Magnus Enzensberger, Paul Celan and Nelly Sachs, Heinar Kipphardt and J. Robert Oppenheimer, and the deep distress of Martin Heidegger scribbling around Einstein's famous formula.

Figure 5: Exhibition Strahlungen. Atom und Literatur / Radiations. Literature and the Atomic Bomb (courtesy of DLA Marbach, photo: Chris Korner).

In its special style of communication with the outside world Marbach has for some decades been dominated by the type of the connoisseur. While everywhere else in the world of arts and learning this cultural archetype was pushed back and slowly lost ground, here – between the archive and the showcase museum – he found some sort of natural reservation. The connoisseur considers himself mainly as a guardian of holdings with which he is intimately familiar and which he tries to protect and hand down. His cognitive acts consist mainly in distinguishing different hands and attributing works, in eliminating forgeries and in connecting pieces of art with the lives of artists. The biography of the artist is the central axis of his intellectual and practical performance.

The connoisseur cultivates a deeply rooted mistrust against any kind of analysis, theory or interpretation. He considers the academic scholar as his natural antitype and castigates his lack of empirical knowledge. He refuses to think in transfer realities like media, discourses etc. He trusts in the mutual transparency of similar minds that need only hints to understand what he wants

them to see and understand. What he wants them to see and understand is his *Bewusstseinsinhalt*, the contents of his mind. He dislikes the idea of a communication with non-connoisseurs. When it comes to exhibitions, he tries to put the contents of his mind into the showcase.

But if you ask his natural antitype, the academic scholar in humanities, i.e. the *Geisteswissenschaftler*, to produce an exhibition, you won't be happy either. Most of the scholars trained in the humanities – I leave aside the small group of art historians who are familiar with the museum – have been trained to think exclusively in terms of monographic essays and theses. Every problem and every concept they pick up automatically turns into the structure of a scientific essay, footnotes and bibliography included. Our up-and-coming young scholars in the humanities are still (almost uniquely) trained in a way that leads to textual philology – as if a media revolution or a visual turn has never taken place. What they have learned, what they can, and what they will do whenever you ask them a question or give them an idea is to write a scholarly essay (if in reality or only mentally doesn't matter). Out of a hundred young scholars, graduates or post-docs, who apply for a job in our museum, there are only two or three, and sometimes none, who prove an optical or haptical talent, who know how to touch an object or really *see* it. In a literary museum with its natural abundance of seemingly philological objects this predominance of the "monographic thinking" is especially painfully felt.

Figure 6: Dauerausstellung des Literaturarchivs / Permanent Exhibition (courtesy of DLA Marbach, photo: Chris Korner).

This brings me to my conclusion or rather to a short summary of what I have been trying to tell you. Exhibitions, so it seems to me, are especially interesting parts of research processes which may involve people, ideas, institutions, money and media that transcend the narrow space of the museum. The research that is done during the realization of an exhibition is all the more valuable as it is specific. If you confuse it with writing a monograph you lose its epistemic value. If you use what Stefan George would call its *plastische Kraft*, i.e. its capacity of presenting problems and material constellations within a space, you may get results that monographic thinking would

probably never produce – be it new questions. Exhibitions are the better the more you use them for grasping what could not (perhaps never) be written. All the things that can easily be written may find their proper place in the catalogue. Exhibitions put their questions *as forms*, and it's their forms that generate new questions.

Scenography – Opera as a Model for Integrative Design

Uwe R. Brückner

In Germany, museums continue to receive far more visitors than all sports events combined. Increasingly, temporary exhibitions have become especially attractive formats for offering exceptional or even unconventional access to art collections or archives. Indeed, we are witnessing a boom of very successful thematic exhibitions, and not only at major museums like the Guggenheim Museum in Bilbao, Tate Modern in London, Centre Pompidou in Paris or Neue Nationalgalerie or Martin Gropius Building in Berlin. Exhibitions have become a means of edutainment as a way of presenting sophisticated historic, scientific and popular themes to a diverse audience.

ATELIER BRÜCKNER designs scenographic exhibitions since 1997.[1] However, when we had been asked to create an exhibition about opera, we had to ask ourselves if opera as a performing format would be displayable at all and, if so, how opera could be transferred into an exhibition. Soon we found, that the way opera works is rather similar to our way of working: it is the multidisciplinarity that is characteristic for both. The staging of an opera is an integrative process of several disciplines, like concept, design and performance. As the opera does not only employ singers or musicians, but also tailors, carpenters and many other craftsmen, we do not only employ architects or interior designers, but also other professionals like graphic artists, light designers, communication designers or art historians.

But what does opera mean to us today? Is there something interesting to the general public beyond the cliché of opera as the privilege of the elite? If so, what is its fascination that can make people even today curious about a genre more than four hundred years old? Is there any desire or relevance for a contemporary interpretation of a two hundred year-old composition? And even more important: Does this format match the expectations of presenting a subject like opera, whose essence is in the directness of performance and the real-time experience? Is it possible to achieve a transformation of its dynamics and dramaturgy into the more-or-less static format that exhibitions traditionally pretend to be? These are all questions, which the scenographer of an exhibition must consider when addressing the general public with something that seems, at first sight, as austere as dry archival documents. In reality, these documents are the signposts of a complex and passionate process from the original idea of an opera, to its scenographic and musical realization that this exhibition attempts to share.

Both formats – theatre and exhibition – use the same resources by synchronizing them in a determined and choreographed space of light, sound, time-based media (motion pictures), and setting. Scenography means having an "orchestra" of media, which are ultimately composed and defined in a kind of score (partitura). These several media are comparable to musical instruments, each playing a major part in a specific area or time frame. Together, they form a body composed of space, sound, narrative and emotion.

In the prevailing perception of opera, we generally think of it as an event, in which the audience faces a raising curtain that reveals a stage representing the world of music and performance offering only a fixed viewpoint. On the contrary, in an exhibition, the visitors can stroll around; they constitute an anarchical and independent parameter, which must be taken into account (and might be used as a choreographic advantage). But we also think of red carpets, evening dresses,

[1] http://www.atelier-brueckner.com

chandeliers, singers in costumes, the silence before the overture starts and the frenetic applause at the end of an evening full of emotion. However, the most exciting part of an opera is the world behind the curtain. Opening opera to a wide audience means giving access to the backstage world both physically (in the scenography) and conceptually (in the storytelling). The exhibition intends not only to satisfy experts, but also to attract and reach those who never thought that they would ever be interested in opera at all.

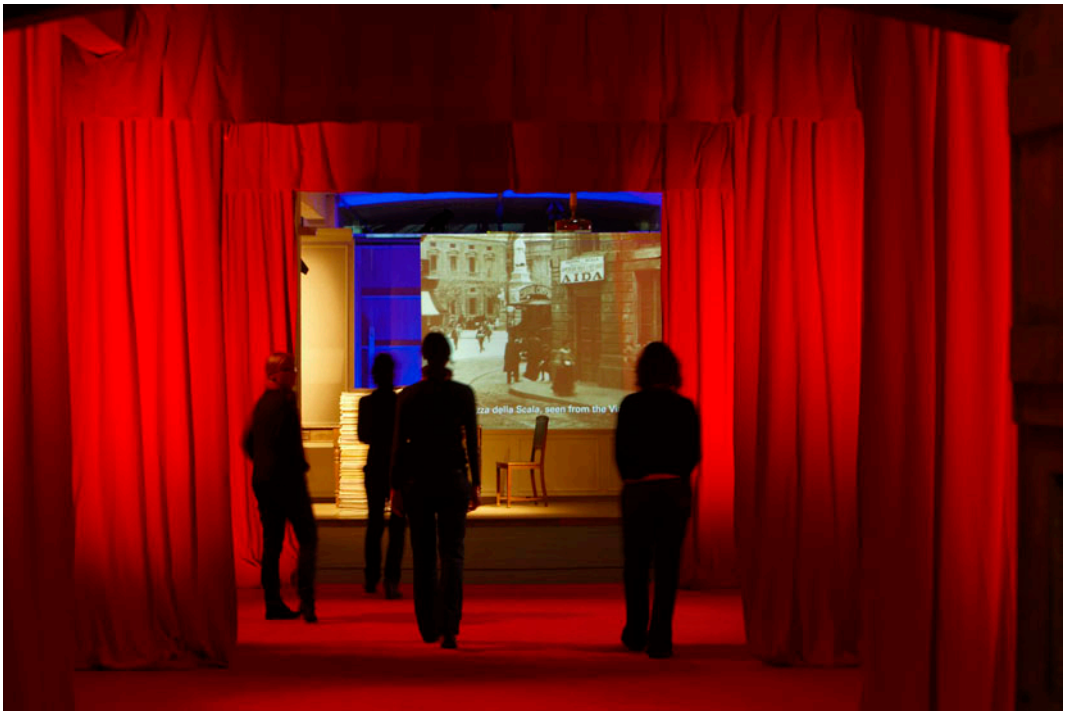

Figure 1: Prologue (courtesy of A. T. Schaefer).

The Exhibition

The exhibition is animated by the outstanding collection of the Ricordi Archives[2]: collections of autographs, manuscript and rare printed librettos, letters, and original sketches of stage and costume designs. These treasures are witnesses to 200 years of intensive work in the development and accomplishments of Italian opera, a legacy undertaken by the Ricordis not only as visionary music publishers, but especially as impresarios, opera buffs themselves, and very close friends of their artists. The visitor is invited to participate in the many emotions, joy but also frustration that the different phases in the gestation of an opera can generate.

The exhibition is like a window that gives insight into the complex world of writing, composing, singing, conducting, or staging an opera and opens a door to all those workshops that are usually reserved "for staff only".

[2] With almost two hundred years of history, Casa Ricordi is the oldest Italian music publishing firm still in business. It was founded in 1808 by Giovanni Ricordi, who laid the foundations for what would become the copyright, guaranteed first only in Italy and then on an international level. (http://www.ricordi.it) The Ricordi Et C.'s Historical Archive, the world's largest private music archive, is housed in the Biblioteca Braidense of Milan. Cf. Cennamo, Tino, "A Great Dream Becomes a Reality," in *That's Opera*, ed. Dotto, Gabriele (Munich: Prestel, 2008)

The scenography that frames the entire path generates a typical backstage atmosphere. The fully accessible environments create both an individual and a collective spatial experience. Watching artists paint a backdrop or tailors sew a costume, or strolling through an orchestra pit, are some of these three-dimensional adventures. We call it "staging the stage".

The Making of an Opera

Visitors will be able to experience the work in progress on a journey through the genesis of an opera first-hand, and are given access to the secret space of a theatre's backstage world.

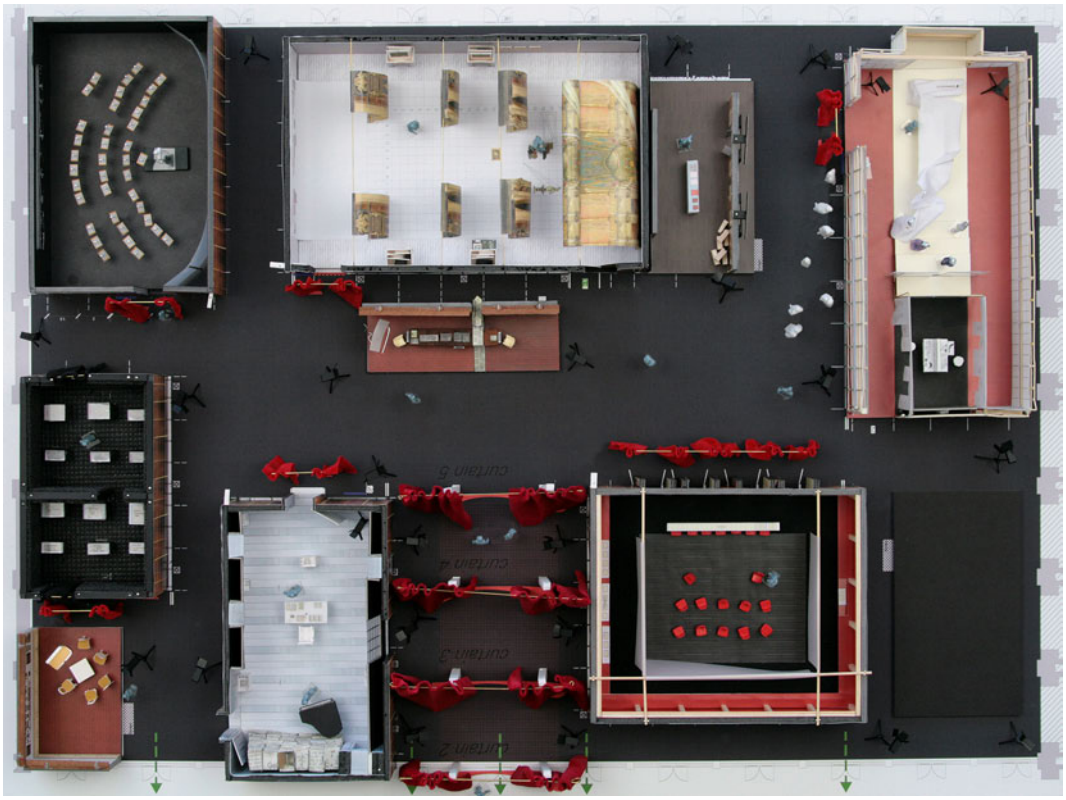

Figure 2: Model Topview (courtesy of ATELIER BRÜCKNER).

This backstage world is structured in the dramaturgical order of the five accessible stages incorporated in five installation cubes featuring "*libretto*", "*partitura*", "*scenografia*", "*voci e costumi*" and finally "*rappresentazione*"[3] – the climax when all the elements come together in a performance. The five stages create a choreographed path that allows the visitor to understand the genesis of an opera – the "making of." That means that the concept of the tour through the entire exhibition derives from the process how an opera is creatively elaborated – dramatic structure of content becomes dramaturgy of concept.

Libretto – or "the sounding narrative"

The first cube is dedicated to the first step in writing a new opera: the creation of the libretto. However, it is not always a straight path from the source of inspiration to the finalized text and from there to the first musical idea. The process of writing is paved with an artist's loneliness,

[3] Respectively in English: libretto, score, theatrical scenography, voices and costumes and representation.

often pushed forward by an entrepreneur's influence, fertilized by discussion with the composer and challenged by the writer's own desire to find the best performable narrative.

Rodolfo's garret in Giacomo Puccinis's *La Bohème*[4], with the dismal but inspirational ambience of the first act, places the visitor in the position of the librettist.

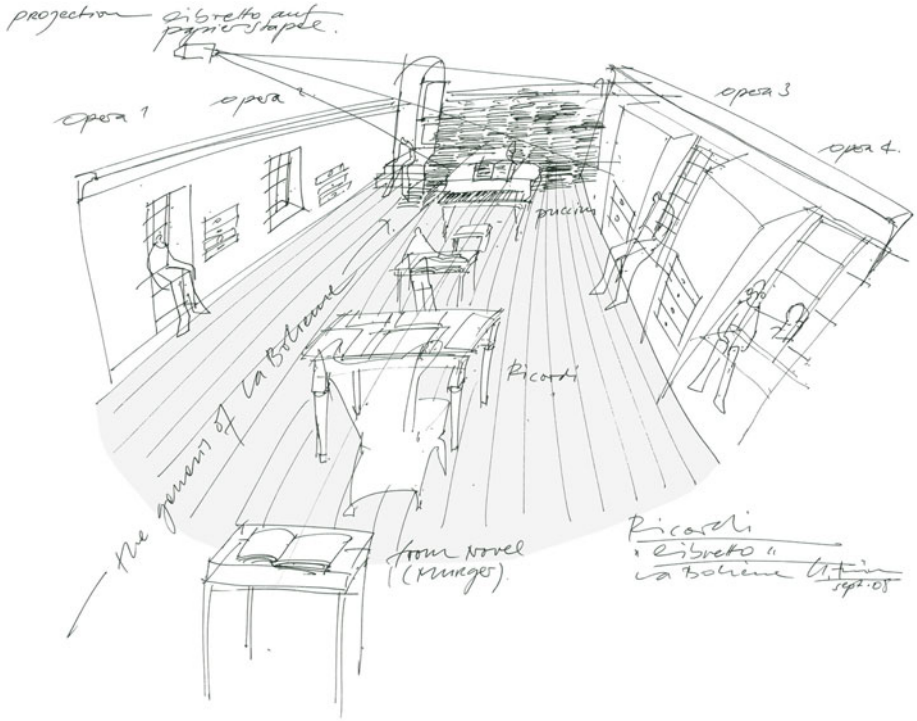

Figure 3.1: Libretto Rodolofo's_Garret_Sketch (courtesy of Uwe R. Brückner).

Figure 3.2: Libretto_Rodolfo's Garret (courtesy of A. T. Schaefer).

[4] Giacomo Puccini (1858-1924), Italian composer, who wrote the opera *La bohème* in 1896.

Partitura – or "to make paper sound"

The room of silence, an absorbing and dimensionless dark treasure box allows intimate contact between the recipient and the manuscripts of Donizetti, Puccini and Verdi.[5] The visitor inhabits the autographs – there is nothing but the awe-inspiring aura of artefact and the imagination of how paper sounds. The intention was to create a dialogic atmosphere between the silence of the space and the items and an intravenous relationship, an intimacy between the recipient and the artefact.

Figure 4: Partitura_Treasure Box (courtesy of A. T. Schaefer).

The "accessible *partitura*" introduces the complexity of a composition by means of an interactive score, inspiring the viewer's admiration for the conductor's ability to form an orchestra. It allows the various instruments to be perceived individually. And probably for the first time, the visitor can follow the real time performance of a score either in print or autograph version on an interactive screen.

[5] Gaetano Donizetti (1797-1848), Giacomo Puccini (1858-1924), Giuseppe Verdi (1813-1901).

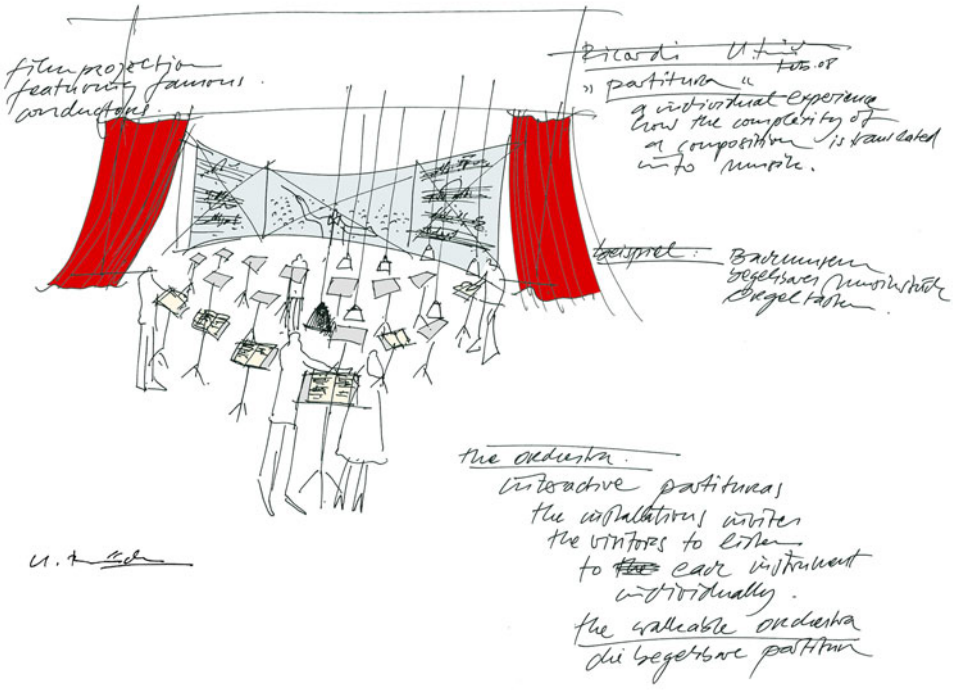

Figure 5.1: Partitura_The Accessible Partitura_Sketch (courtesy of Uwe R. Brückner).

Figure 5.2: Partitura_The Accessible Partitura (courtesy of A. T. Schaefer).

Scenografia – or "an imaginary space"

The stage design tells us in which era and location the performance is taking place, while the staged settings create a visual illusion of the narrative environment. Since opera is a live performance, the stage design is imaginary and real at the same time. The advantage of this exhibition and its major difference from theatre is the individual, physical presence of the viewer, who can walk past the backdrop (in the process of being painted) while assuming the position of a singer. Full-scale original drafts of Adolf Hohenstein's[6] backdrop for *Tosca*[7] revive the images of the world première as it was seen in Rome in 1900. Scaled interactive stage boxes let visitors imagine the huge dimensions of the backdrops used in theatres then.

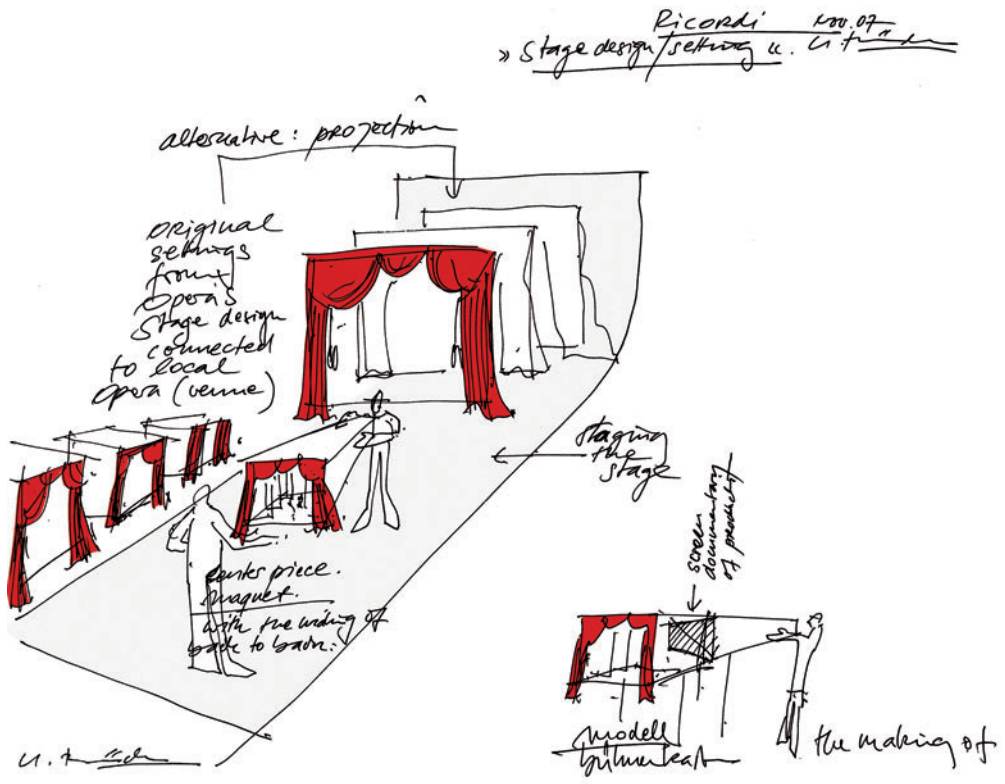

Figure 6.1: Scenografia_Sketch (courtesy of Uwe R. Brückner).

[6] Adolf Hohenstein (1854-1928), art director of the graphic-arts department of Casa Ricordi, where he also served as a set and costume designer, collaborating on several opera productions. A brilliant representative of the Art Nouveau style, his affiche for La bohème was the first of its kind for Italian opera, while those for *Tosca* and *Madama Butterfly* are considered masterpieces of poster art.
Cf. Dotto, Gabriele, ed., *That's Opera* (Munich: Prestel, 2008).

[7] *Tosca* (1900), opera by Giacomo Puccini.

Figure 6.2: Scenografia (courtesy of A. T. Schaefer).

Figure 6.3: Scenografia_Interactive Stage Box (courtesy of A. T. Schaefer).

Voci e Costumi – or "how to express the character of the protagonists"

In opera the drama is very often hidden behind an apparently harmonious but in fact fragile façade. Here, obvious desire and subtle pain challenge the paper-thin Japanese architecture of Cio-Cio San's home[8]. The pregnant atmosphere of waiting is enhanced by the projection onto the looping tailoring of her wedding Kimono. The original drawings of the figurines act as witnesses to the scene. Behind the scenes of Butterfly's house, the visitor experiences the tension and concentration of a dressing room, with a who's who of "*divas*" and "*divos*" waiting for their curtain call.

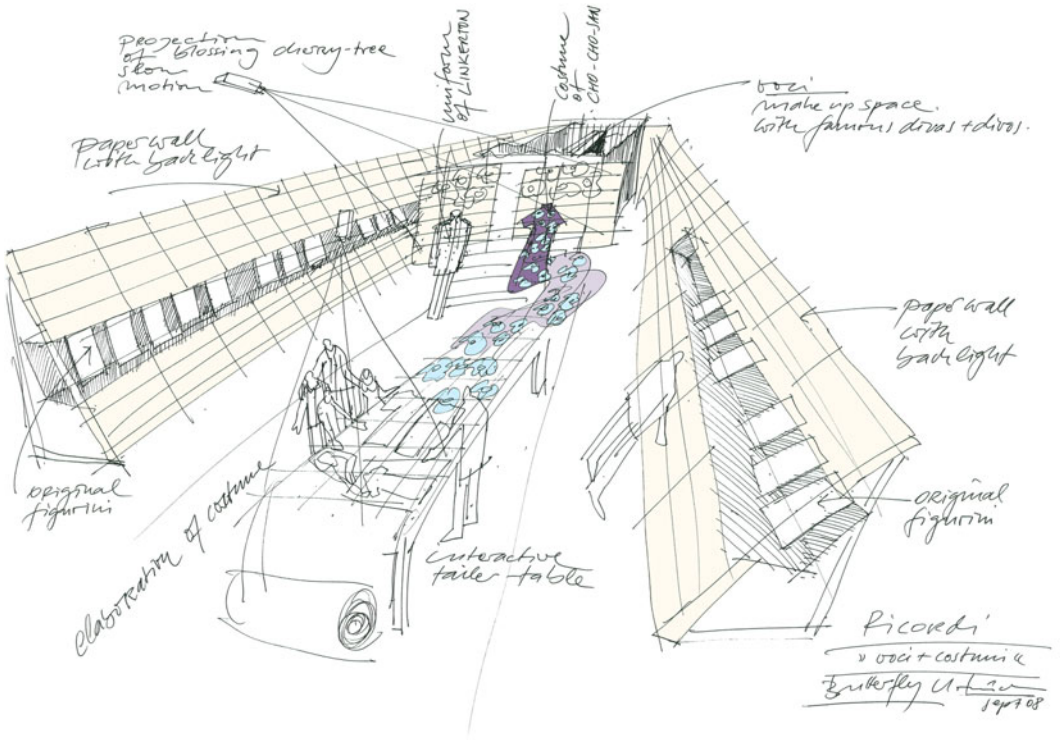

Figure 7.1: Voci e Costumi_Sketch (courtesy of Uwe R. Brückner).

[8] Main character of the opera *Madama Butterfly* (1904) by Giacomo Puccini.

Figure 7.2_Voci e Costumi (courtesy of A. T. Schaefer).

Rappresentazione – or "staging the stage"

The visitors awake on stage for the "*finale grande*". The auditorium mirrors the interior onto a virtual stage via a 270° projection. The visitors can witness the performance from the stage, becoming immersed in the live performance of *Aida*[9] that concentrates almost three hours into a nine minutes making of. The challenge here was to allow the visitors to "participate" in the performance. Thus the visitors instantly play a role as they are staged themselves within a scenography intended to tame the instant.

[9] *Aida* (1871), opera by Giuseppe Verdi.

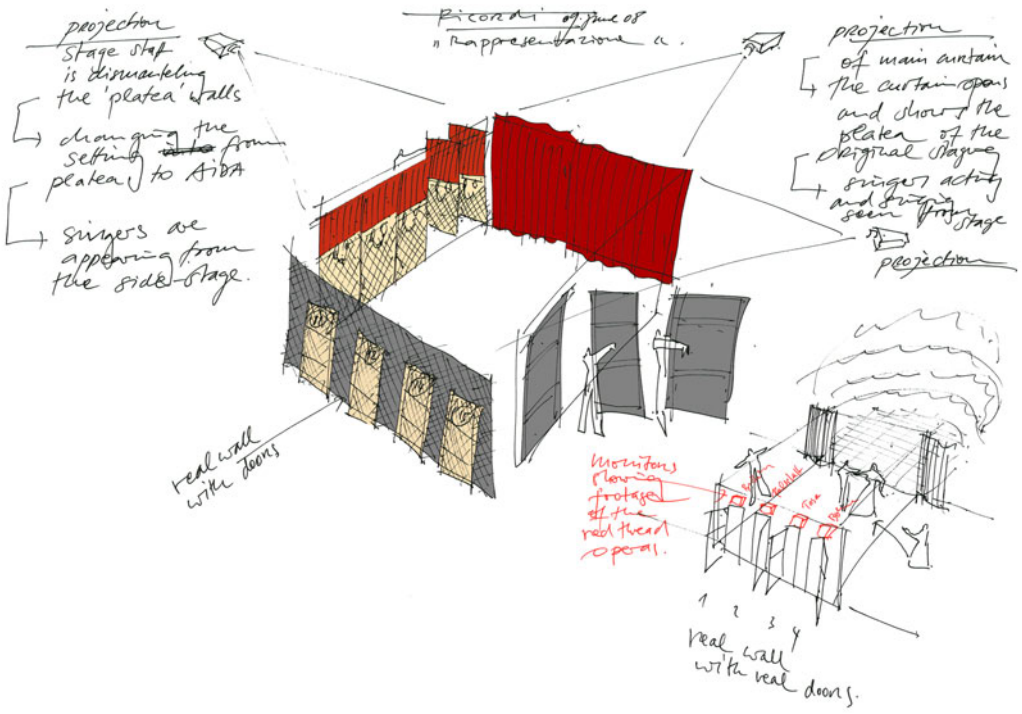

Figure 8.1: Rappresentazione_Sketch (courtesy of Uwe R. Brückner).

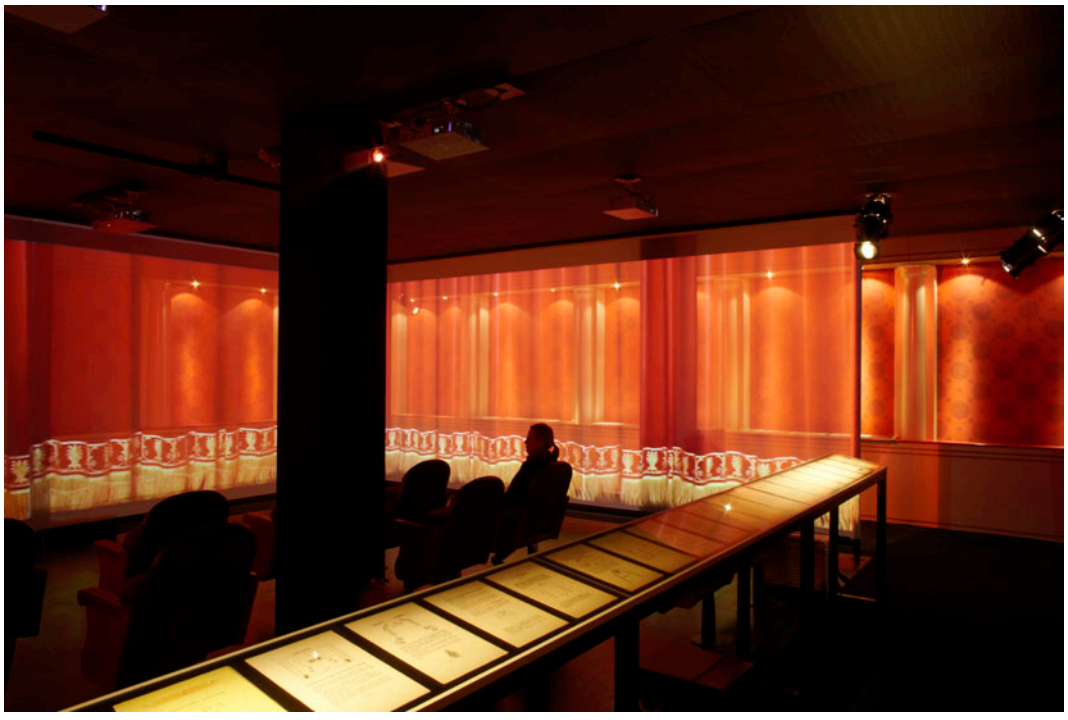

Figure 8.2: Rappresentazione (courtesy of A. T. Schaefer).

Alongside this storyline, there are three individual interactive displays, which cover the history of 200 years of *Casa Ricordi*. For example, Giovanni Ricordi, the founder of *Casa Ricordi*, and his

revolutionary business idea – he invented the "rental" of music scores of all different parts in an orchestra, a system that is still in use today – and the Ricordis being more than just music publishers. They combined financial and commercial interests with the cultural, social and human aspects of music. Many of the most reputable composers of the 19th and 20th century maintained a rather close friendship with one of the Ricordis.

Exhibition as an artistic format of performing content, however, provides a physical and authentic access to the aura of artefacts and their biographies. Scenographic design means staging the content alongside a dramatic curve of suspense to keep the visitors in an altering but constant curious mood of expectation. Opera as a performing format is a vital source of dramatic structures and therefore a model for integrative design.

Paper begins to speak, the scores whisper melodies, and the word is given to the protagonists. In this kind of scenography, the visitors take part; they become actors in an installation, what Richard Wagner would call a *Gesamtkunstwerk*[10] – a "total artwork" – according to his conception of the music drama. In the figurative sense, this backstage environment plays with the metaphor of Ricordi's legendary engagement and carefully balanced relationship with all their singers, composers, and clients.

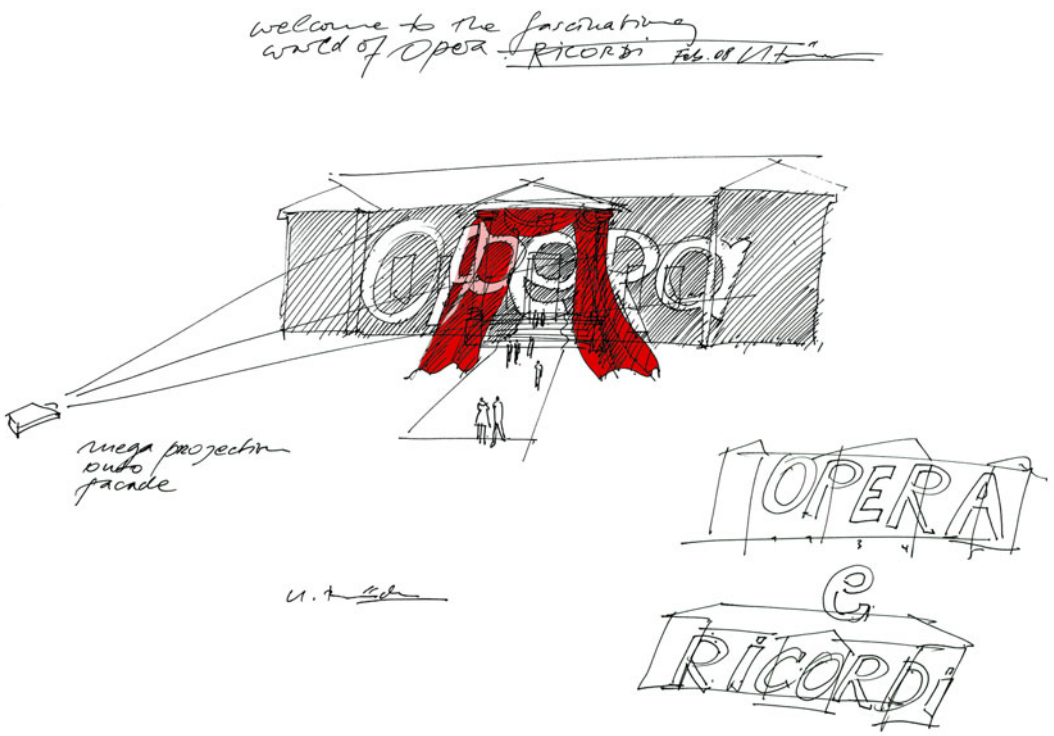

Figure 9: Preprologue_Sketch (photo: Uwe R. Brückner).

[10] „Das große Gesammtkunstwerk, das alle Gattungen der Kunst zu umfassen hat, um jede einzelne dieser Gattungen als Mittel gewissermaßen zu verbrauchen, zu vernichten zu Gunsten der Erreichung des Gesammtzweckes aller, nämlich der unbedingten, unmittelbaren Darstellung der vollendeten menschlichen Natur, – dieses große Gesammtkunstwerk erkennt er nicht als die willkürlich mögliche That des Einzelnen, sondern als das nothwendig denkbare gemeinsame Werk der Menschen der Zukunft." (Wagner, Richard, *Das Kunstwerk der Zukunft* (Leipzig: Wigand, 1850), 32).

The unique scenography of the exhibition creates an emotional and lasting memory, a sort of corporate relationship between the fascinating world of opera and the visitors, just like the Ricordis achieved through their entrepreneurial spirit and unconditional passion for opera.

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Do Things talk?

Thomas Söderqvist and Adam Bencard

Words and things run complicated circles around one another in academic thought and writing, interweaving slippery issues of epistemology and ontology. This dance is one of the cornerstones of Western philosophical debate, and more often not trying to define what a thing is becomes a convoluted exercise, punctuated by frequent references to Heidegger or similar luminaries. Words and things also run equally complicated, but slightly different, circles around one another in the context of displaying actual historical things in museums. The curator's task – to collect, register, and display material artefacts – leads to a parallel series of discussions on what exactly materiality is. What qualities do we ascribe to things/artefacts, and how do we best align these qualities with their functions in exhibitions? How can we untangle and make sense of the ways in which we understand our relationships with things around us. And how do we best employ this understanding in our curatorial practices? Does materiality matter? Can one display ideas? How are things talked about in academic discourse, and how does such thinking relate to the collecting and displaying of historical things?

This essay was sparked by such questions and by our ongoing discussions at Medical Museion in Copenhagen, where, over the last couple of years, we have investigated the conditions for displaying contemporary medical artefacts in public exhibitions.[1] An issue that has cropped up increasingly in our discussions is what kinds of vocabularies can be used for understanding the relation between human visitors and biomedical museum objects. There seems to be a current trend in Academia to use expressions like 'things that talk', 'evocative objects', 'ideas in things', 'the secret life of things', and 'biographies of things.' In this essay we will discuss the validity of such current 'things that talk' vocabulary.

But first it seems worthwhile to just dwell on a more pedestrian meaning of the notion 'things that talk'. An example of such a more straightforward meaning is a recently published book by Tom Igoe, an artist and specialist in physical computing, titled *Making Things Talk: Practical Methods for Connecting Physical Objects* (Igoe 2007). Igoe's book is a wonderful guide for anyone who wants to learn how to connect all kinds of physical devices with each other and with humans, using microcontrollers, Bluetooth technology etc. As the publisher says, "the possibilities are practically endless." Worth noting here is that *Making Things Talk* is manifestly about making things talk to each other: "This book is written for people who want to make things talk to other things."[2] Obviously, the author does not believe that things are able to talk to other things (or to

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[1] See, e.g., Mordhorst, Camilla, "Tingenes rige – mellem raritet og repræsentation," in *Fortiden for tiden: Genbrugskultur og kulturgenbrug i dag*, ed. Braae, E. and M. Fabricius Hansen (Århus: Arkitektskolens Forlag, 2007), 112-129; Mordhorst, Camilla, *Genstandsfortællinger: Fra Museum Wormianum til de moderne museer.* (Copenhagen: Museum Tusculanum Press, 2009), 217; Söderqvist, Thomas, "Who's Afraid of the Recent Biomedical Heritage?" *Opuscula Musealia* 15 (2006): 99-105; Söderqvist, Thomas and Adam Bencard, "Making Sense or Sensing the Made? Research into Presence-Production in Museums of Science, Technology and Medicine," in *Research and Museums*, ed. Cavalli-Björkman, G. and S. Lindqvist (Stockholm: Nationalmuseum, 2008); Söderqvist, Thomas, Adam Bencard and Camilla Mordhorst, "Between Meaning Culture and Presence Effects: Contemporary Biomedical Objects as Challenge to Museums," Studies in the History and Philosophy of Science 40, no. 4 (2009): 431-438.

[2] Igoe, Tom, *Making Things Talk: Practical Methods for Connecting Physical Objects* (Sebastopol: O'Reilly, 2007), 1, our emphasis.

humans or animals) all by themselves. As a specialist in physical computing, he takes for granted that we have to install technical devices in things deliberately, in order to make them interact with other things, or with us, in a way that could be likened to talk. This is, we would venture, what most people think of when they hear the phrase 'things that talk'. We take for granted that it is us (the humans) who make things talk and interact and influence other people through radio waves and electronic communication devices in a way that could be likened to talking.[3] Only children believe that a doll, like Thomas Edison's 'Talking Doll' from 1877, can really talk.[4]

Figure 1: Talking doll with internal phonograph (Thomas Edison, 1877). Edison allegedly thought the voices of "the little monsters" were exceedingly unpleasant to hear
Source: http://davidbuckley.net/DB/HistoryMakers/1890EdisonTalkingDoll.htm
Access from 05-06-09.

Yet in recent years, in the wake of the growing interest in things and material culture among ethnographers, museologists, science studies scholars and historians of science, there has appeared this new vocabulary, which has substituted the pedestrian meaning of the phrase 'things-that-talk' with a seemingly more literal understanding.[5] For example, the organizers of a workshop of the Wiener Arbeitsgespräche zur Kulturwissenschaft, held in Vienna in 2008, not only invited participants to bring objects to the meeting.[6] They also arranged sessions where participants could, they said, argue and discuss with the objects ("mit den Dinge zu argumentieren und diskutieren"), and they hoped that the objects, too, should have their say in the discussions ("die Dinge gleichsam selbst zu Wort kommen (lassen)"). Similarly, when the German Society for Ethnography met in

[3] There is of course also a historical and religious tradition for communing with the spirits of inanimate objects like trees, rocks, springs or mountains.

[4] You can hear a recording of Edison's doll at www.archive.org/details/EdisonsTalkingDollOf1890.

[5] Maybe we could talk about a 'material turn', which those of us who work in museums have every reason to welcome, because I think it may help raise the intellectual quality of our curatorial work.

[6] See http://www.trafik.or.at (accessed, May 6, 2010)

Berlin in November 2008 under the general theme of "kulturwissenschaftliche Perspektiven auf die materielle Kultur,"[7] the organisers not only wished to highlight things and their materiality – they also gave things the status of agents and competent language users. The catch-phrase of the Berlin meeting was "Die Sprache der Dinge" (the language of things) and in the call for papers the organisers emphasised "die Wirkmächtigkeit der Dinge" and "ihre Kulturgenerierende Funktion". What a pedestrian observer would call inanimate things were, in the words of the German ethnographers, turned into "Handlungsträger und Akteure", into "Vermittler und Übersetzer" and into "Produzenten von Bedeutungen, von sozialen Beziehungen und Praktiken, von Identitäten, Wertvorstellungen und Erinnerungen." In other words, the German ethnographical society did not only want to promote the 'material turn', they also suggested that things are speakers, actors, mediators, translators and producers of all possible social and cultural meanings. They seemed to hold out the promise of new forms of knowledge, previously hidden by a lack of attentiveness to the private lives and languages of objects.

Why are parts of Academia currently obsessed with a vocabulary that suggests that we should 'read' inanimate objects as if they were thinking, talking and acting? What does this kind of vocabulary of agency add to scholarly and practical museological discourse? Is it a fruitful conceptual foundation for the renewal of museum display practices? Does conceiving of things as having the ability of speaking and acting provide us with new insights? Or does the "things that talk"-metaphor (if it is a metaphor?) rather muddle the issues at stake?

At the outset, this trend is perhaps, as Bill Brown has suggested, tied to a desire to overcome a traditional empiricist clear cut separation of things and persons. Brown notes the existence of such a desire in the titles of books like those mentioned at the beginning of this essay:

> The titles [*The Tears of Things*, *Things That Talk*, *Ideas in Things*, 'The Secret Life of Things.'] alone perform some anthropomorphizing work. The titles mark an underacknowledged postmodernity: the confusion of object and subject, animate and inert, overcoming what's known now, in the political philosophy of science, as modernity's artificial distinction between persons and things. At the very least, objects promise to become, say, somewhat different objects of knowledge.[8]

In a sense, it is this tension – between a desire to overcome the naivety of any clear distinction between people and things and an anthropomorphizing movement – which this essay will explore.

First, why this vocabulary? It seems to draw on several sources for intellectual inspiration. One is the actor network theory by Michel Callon, Bruno Latour, John Law and others, who claim, among other things, that non-humans and inanimate 'things' have agency too (the technical term is actants).[9] Surely, actor network theorists deny that agency presupposes intentionality, but since the theory is founded on a general model of semiotics, we believe it sustains the notion of 'things-that-talk', even without recourse to intentionality. Another important inspiration might be the work done in anthropology to reinvigorate the study of objects and things, epitomized in the essays collected in *The Social Life of Things*[10]. In this volume, Appadurai and the contributors articulate a 'methodological fetishism', which focuses primarily on objects themselves, rather exclusively on the social functions and networks surrounding them. This perspective sees things

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[7] See http://hsozkult.geschichte.hu-berlin.de/termine/id=9883 (accessed, May 6, 2010).

[8] Brown, Bill, "Reification, Reanimation, and the American Uncanny," *Critical Inquiry* 32 (2006): 175.

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

[10] Appadurai, Arjun, ed. *The Social Life of Things: Commodities in Cultural Perspective* (Cambridge: Cambridge University Press, 1986).

as moving in and out of social circulation, giving rise to the idea of writing biographies of things, focusing on their changing cultural careers and their lives as social markers.

But in this essay, we would like to address some of the assumptions in another possible source, a volume titled *Things That Talk*, edited by historian of science Lorraine Daston a few years ago.[11] In her introduction to the volume, Daston writes that particular things do not just repeat our language, like tape-recorders (cf. Edison's doll), but they actually "talk to us". They are "eloquent" and "talkative".[12]

Daston is insistent in her attribution of eloquence to a certain form of materiality, and acutely aware of trying to overcome a gap between meaning and matter. This gap is evoked in a manner of different ways, and is tied to a greater philosophical discourse about nature and culture, persons and objects, art and nature, objective and subjective, etc. Daston points both to the lure and the danger of Barthes 'mythical objects'. The lure is the fertile inscription of cultural values on things, and the possibility of performing cultural analysis on things. The perceived danger is that the 'thingness' of things (what ever that might be) disappears completely. This is a danger because "some things speak irresistibly, and not only by interpretation, projection, and puppetry. It is neither entirely arbitrary nor entirely entailed which objects will become eloquent when, and in what cause. The language of things derives from certain properties of the things themselves, which suit the cultural purposes for which they are enlisted."[13]

Thus the talkative qualities attributed by Daston (and some of the contributors to the volume) to the materiality of things are embedded in a paradoxical relationship between meaning and matter. Things, in this conception, have a language and act upon us with their eloquence, but their speaking is based on their materiality: "Even the most malleable things treated in these essays have a bony materiality that makes them what they are," Daston notes[14], and elsewhere states that "things communicate by what they are as well as by how they mean" [15]. But if Daston is really interested in bony materiality and stubborn thingness, why, then, are things given qualities of an intentional actor? Why this use of linguistic metaphors? Why are the things talking, when the introduction warns of a loss of the 'thingness' of things? And what would it mean if things were, in fact, eloquent?

We believe that this kind of vocabulary might have consequences for the way museum people create and understand their exhibitions. If museum artifacts actually are eloquent and talkative, if they are actors, translators and producers, we would have to pay closer attention to this linguistic phenomenon when we display them.[16]

But do scholars really mean this 'things that talk'-talk literally? It seems unlikely that we are witnessing a collective expression of latter-day fetishism, a revival of the 'primitive' religious practice to attribute powers to inanimate objects, like stones or pieces of wood. Indeed any hint of a revival of fetishism in Academia is of course denied. When a British historian of science gave a paper along these lines in a meeting on museum exhibitions in Manchester in 2008, one of us mocked him by raising a pen to the ear, saying "I cannot hear anything". The speaker was offended: "You're poking fun at me", he said, "of course it doesn't talk". "I didn't mean to offend you, but

[11] Daston, Lorraine, ed. *Things that Talk: Object Lessons from Art and Science* (New York: Zone Books, 2004).

[12] Ibid., 24.

[13] Ibid., 15.

[14] Ibid., 18.

[15] Ibid., 20.

[16] Or perhaps we should say that we ought to pay closer attention to how they, the artefacts, choose to display themselves to us?

then please tell me what do you really mean by 'things that talk'"? The speaker said something to the effect that we should not take the eloquent qualities of things literally. Lorraine Daston, in the introduction to *Things that Talk*, is quite adamant about this: Things "do not literally whisper and shout"[17].

So 'things that talk' shouldn't be understood literally. Should it be understood metaphorically then? This is the way we understand the syllabus for a course on "Thing theory" which has been held at Columbia University for some years now, and which deals with the "intensified concern with materiality and the ambiguous category of 'things' [that] has emerged in the past decade as an explicitly interdisciplinary endeavour involving anthropologists, archaeologists, art historians, and literary critics among others". The syllabus concludes:

> The new field of material culture studies […] inverts the longstanding study of how people make things by asking also how things make people, how objects mediate social relationships – ultimately how inanimate objects can be read as having a form of subjectivity and agency of their own.[18]

This is a metaphorical understanding: We, the humans, read subjectivity, agency and language abilities into things. But in *Things that Talk*, there seems to be a suggestion of something more going on than mere metaphorical talking. In her introduction, Daston first notes that those who are sceptical of talkative things will insist that all this talk is "at best metaphoric"; then she accepts such sceptical doubts only "for the sake of argument," and finally she adds: "there is still the puzzle of the stubborn persistence of the illusion [that things talk], if illusion it be".[19]

What one should make of this metaphysical uncertainty is not quite clear, but we would like to offer an interpretation. What we suggest in this paper is that the ambiguity between the metaphorical and literal understanding, between illusion and reality, that permeates the 'things that talk'-talk has something to do with the persistence of the linguistic turn in the humanities. Terry Eagleton, the British literary critic, once noted, with his usual acerbic wit, that the theoretical interest in the body during the 1980s and 1990s was a way of "having one's deconstructive cake and eating it too"[20]. Books on the history and culture of the body made the students wriggle under the emotional effects of reading about sex, death, torture and medicine, while at the same time explaining such effects away into the mists of discursivity; Thomas Laqueur comes easily to mind, so does Judith Butler, who raises the problem of the materiality of the body, just to translate it into a subset of problems about language and consciousness. The problems of the materiality of things is seemingly both explained and explained away. And the linguistic turn continues as usual.

What we suggest, then, is that the current 'things that talk'-vocabulary may have something to do with wanting to pay attention to the thing-ness of things – their 'bony materiality' and yet keep one's language- and culture-centered approach intact. To allow things become actors with an uncanny ability to speak to us, is (we suggest) a license to maintain the set of scholarly tools and languages associated with the linguistic and cultural turns in the humanities, while still appearing to do something new. By claiming that things talk, scholars today can maintain a certain set of institutionally and traditionally enshrined ideas, while seemingly engaging with a new agenda. Rather than exploring the presence and effects of things qua things, things are turned into something which we, as academics that are trained in a hermeneutical and interpretational tradition, can relate to immediately. It is business as usual on a new subject matter, which still holds out the promise of being something different.

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[17] Ibid., 12.

[18] http://www.columbia.edu/~sf2220/TT2007/web-content/Pages/syllabus.html (accessed, May 6, 2010).

[19] Daston, *Things that Talk,* 12, our emphasis.

[20] Eagleton, Terry, "Body work," in *The Eagleton Reader*, ed. Regan, Stephen (Oxford: Blackwell, 1998), 158.

We also suggest that ultimately this line of thinking (and acting) is part of a line of thought that makes materiality and the outside world (the world outside of the actor, independent of his or hers actions) not just unknowable, but, more radically, unthinkable. By doing this, it restricts itself to our experiences of the world, which it sees as linguistically structured. French philosopher Quentin Meillassoux has called this the "correlationist circle", which he explains as follows:

> The first decision is that of all correlationism – it is the thesis of the essential inseparability of the act of thinking from its content. All we ever engage with is what is given-to-thought, never an entity subsisting by itself. This decision alone suffices to disqualify every absolute of the realist or materialist variety.[21]

Correlationism is in a sense a way of addressing the problem of the relationship between the subject and the object, the person and the world. Meillassoux presents philosophy after Kant as being not quite idealist, nor is it realist. As he argues, we no longer believe us capable a direct access to the world around us, while at the same time not believing that our perceptions alone make up the world entirely. This is the essence of correlationism: We only ever have access to the correlation between thinking and being, and never to either term considered apart from the other: "Correlationism [is] any current of thought which maintains the unsurpassable character of the correlation so defined"[22].

The correlationist strategy consists in demonstrating that the object can only be thought as it is given, and it can only be thought as it is given for a subject. In drawing our attention to givenness for a subject, correlationism thus demonstrates that we can never know what the object is in-itself, but only what it is for-us. In short, any truth one might articulate is not a truth of the world as it would be regardless of whether or not we exist, but only a truth for-us. We never know an object as it is in-itself independent of the structures that condition appearances. Correlationism thus implies a general 'textualization' of the world, where the correlationist does not speak directly of the world (to do so would be to fall into naïve realism) but only talks about talk about the world.

Correlationism, then, restricts itself to providing philosophical arguments about the nature and structure of our experience of the world. This philosophical position, which can be identified with Heidegger and Wittgenstein, was married to the linguistic turn from the 1970's onwards, thus making any investigation of materiality ultimately an investigation of our linguistically structured appropriations of materiality – an investigation that more often than not turned into an investigation of mind over matter.

An example of the view that objects are inherently, and in all significant ways, social and linguistic constructs is Rom Harré's essay "Material Objects in Social Worlds"[23]. Harré suggests that a thing comes into being primarily through symbolic and discursive action and only secondarily through a material order: "Some material things are passive in relation to people, other things are active. Whether something is passive or active is largely story-relative."[24] Things become social objects, and non-social objects are at the very least not interesting to the social scientist, and perhaps not even interesting at all, by being embedded in a discursive construction: "Nothing exists in the social world unless it has been introduced into that world by a human social and constructive act."[25] The inferred conclusion is that nothing goes on in our social lives, which is not first and foremost framed by discursive activity. Thus, the notion that there is something real

[21] Meillassoux, Quentin. *After Finitude: An Essay on the Necessity of Contingency* (London: Continuum, 2008), 36.

[22] Ibid., 5.

[23] Harré, Rom, "Material Objects in Social Worlds," *Theory, Culture and Society* 19 (2002): 23-33.

[24] Ibid., 23.

[25] Ibid., 24.

or material is merely the effect of a certain stable symbolic order, and if we are to understand an object or thing 'fully' we must enquire primarily into the social and symbolic web into which an object is embedded.

Harré recognizes that some might claim that the physical, chemical and biological attributes of the material environment constrains the social arrangements that transforms the environment to human needs. But, he argues, "what is taken as salient from the indefinitely open set of material features of an environment depends on the narratives dominant at a certain time and place."[26] Thus the material features of an environment is taken as being indefinitely open, and the important part – how it is absorbed and made a part of social life – is something that is governed by narrative, symbolic and discursive structures of a given time and space. Essentially then, the view that Harré promotes holds that "to become relevant to human life material beings must be interpreted for them to play a part in a human narrative."[27] In this view, the narrative, symbolic and discursive placement of an object is what is 'real' and what, ultimately, should be the dominating way to study a social object. Studying the physical properties of an object, the thin description, is valid if you are a natural scientist, but anyone interested in historical, cultural and social matters should focus on the discursive structures that make the object salient to us.

In her introduction to *Things that Talk*, Daston obviously wants to tamper the sort of thinking about things that Harré represents with sensitivity towards the 'bony materiality' and general stubbornness of the 'thingness' of things. The point, then, is that the 'things that talk'-rhetoric attempts to reinstate a new materialism by making things more like us. By endowing things with anthropocentric qualities – even if it is just done with cautious hesitation or as a metaphor for something else – it attempts to embrace the material world while still maintaining traditional ways of writing, studying and representing objects. Making the world like us means that the scholar can keep employing the sharply honed academic tools at her disposal. Writing the biography or the secret life of an object is not much different from writing about a historical movement or person.

We suggest further that the main intellectual project behind 'things that talk'-talk is to historicise – and such a desire necessarily rests on an epistemological drive. *Things that Talk* taken as a whole is founded on the deep-seated belief, entrenched in thirty years of contextual, historicising tradition in the history of science, technology and medicine, that the job of history writing is to historicise the seemingly immutable and natural boundaries that exists between things and people in a given time and space. The authors want to deliberate on how a given historical period establishes what counts as a thing – a speaking thing, in this case – and this project is a genealogical one, based on an epistemological desire to reveal the shifting tides of ideas about selfhood and subjectivity. This is apparent in Lorraine Dastons own essay in *Things that Talk*, entitled "The Glass Flowers"[28], which is brimming with brilliant expositions about the history of biology and shifting ideas and practices in science, and which shows (with great care and effort) the complex network of thoughts and ideas that surrounded the collection of glass flowers. On the last pages of the essay, Daston ponders, almost as an afterthought, the passionate support that this collection arouses, despite being of little use to botanists and having had little impact on the development of glassware design, and suggests that the flowers exude "a real presence" that they share with other hallowed things.[29] However, getting to the bony materiality of the glass flowers, and understanding their 'real presence' – something that is of particular relevance in the context

[26] Ibid., 31.

[27] Ibid., 32.

[28] Daston, Lorraine, "The Glass Flowers," in *Things that Talk: Object Lessons from Art and Science*, ed. Daston, Lorraine (New York: Zone Books, 2004).

[29] Ibid., 253.

of the display of things in museums – would require, it seems to us, going about the job differently. For curators of collections and exhibitions, the 'real presence' of the objects would have to be the starting point, rather than the afterthought.

There is no doubt about the validity and necessity of such projects like that presented in *Things that Talk*. But it is, we believe, a project that does not provide the necessary tools for getting closer to the bony materiality of things. Getting closer to things will require, we believe, that we pay closer attention to how we define the mediation of our relationship to the world. Does it, as the linguistic turn would have, primarily reside in a linguistically structured appropriation, or is it perhaps rather the case that the way in which this mediation occurs is more material than linguistic, i.e., that we appropriate with our bodily faculties prior to and irrespective of any linguistic appropriation of the world? We would argue that we are not first and foremost cognitive, symbolically structured language users, but rather physical structures with a variety of physical abilities. Language is a second-order structure in our appropriation of the world, not a primary one. This is, we believe, a more fruitful way to explore the relationship between humans and objects in the museum.

So, what's the alternative, unless we want to lapse into a 21st century version of Edison's doll, putting voice chips and speech recognition chips inside things?[30] The easiest solution, we suggest, will be to begin to search in the ontological terrain outside language and semiotics. Thus we suggest a shift in focus, from a linguistic understanding of how things influence us, to a physical and material understanding of the power of things. We suggest that curators should pay closer attention to the immediate physical presence of things. For example:

- how things are sources of electromagnetic radiation of different wavelengths, from the visible spectrum to the infrared, which elicits nerve reactions in the sensory cells in the retina.

- how things have a material surface that exerts pressure on different kinds of tactile receptors in our skin.

- how foreign molecules interact with the olfactory receptor molecules in our nose and the T-cell receptors in our immune system.

That is were the power of things resides. It can be mundane and everyday – or sublime – but it's always merciless.

Thus we would suggest that curators turn the tables and rather than making the world more like us (endowing things with the ability to speak) we see ourselves more like the world. What if we, rather than enveloping things in a rhetoric of talking, acting, communicating and other qualities of the human actor, we try to engage with the qualities in us that is related to objects on a physical level? What if we conceive of a new materialism that makes materials of us? This, of course, means engaging directly with the sciences that engage with and explain the world through material qualities, whether it be post-genomic protein research, cognitive sciences, translational surgery and transplantation, stem cell research, or a sleuth of other sciences that explain how we engage with, participate in, are transformed by, and manipulate the world on a material level. It

[30] "Voice chips and their newer partners, speech recognition chips, are small low power silicon chips that synthesize voice, play prerecorded voice messages, or recognize voice commands. Although this functionality is not new, what makes voice chips unique is that they are small and cheap enough to be deployed in many, in fact almost any, product." Jeremijenko, Natalie, "If Things Can Talk, What Do They Say? If We Can Talk to Things, What Do We Say?" *Electronic Book Review*, March 5, 2005, http://www.electronicbookreview.com/thread/firstperson/voicechip (accessed, May 6, 2010).

will mean abandoning the comfortable realm of social and cultural studies, and instead working to connect scientific and cultural explanations. It will mean abandoning enshrined academic truths about the separation of disciplines.

To shift our attention to this merciless power of things over our bodies and minds means that we have to realize that physical things have power qua their lack of agency. Because things lack agency, they also lack the ability not to influence us. A thing can never decide to stop influencing us. There is no room for negotiation here; no space, however small, for dialogue. Things influence us with their raw material power - and the only way we can stay out of their constant and merciless influence is to move out of their sphere of radiation. We can move things to a closed room where their exuded molecules will not reach our nose. We can put up a screen between the thing and ourselves so that we are not affected by reflected light rays. We can travel to the moon to diminish the pull of gravity if necessary. But we can never ask a thing to stop influencing us.

The way things work on us, physically, takes place in imagination, too. When museum visitors are confronted with a portable amputation saw from the early 19th century, they sometimes faint. Why? Hardly because they imagine how the saw 'speaks' to them on the operating table. But because they imagine how it would feel to have the sharp steel blade cutting into their flesh, slashing bundles of sensitive nerve endings, bursting wave after wave of excruciating pain to the brain. That sensation is pre-linguistic – a beast screams as much as a college professor – and there is no place for talking and negotiation in this procedure (not even metaphorically). To use 'talking' and 'evocative' metaphors to describe what happens on the operation table blurs these raw, mundane material effect of the amputation saw that the surgeon applies on your body. This is the only 'language' that medical matter uses when it 'speaks' with the patient. And our imagination knows that.

There does not seem to be any reason to assume that other material things should, in principle, affect us differently. Not even the invisible and heavy-science loaded objects that characterize contemporary medicine, i.e. cellular and molecular objects. They, too, influence our bodies, and they often do so more than classical medical objects. Their influence is also physical and chemical only – and they are very, very silent.

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Arguing with Objects – The Exhibition as a Scientific Format of Publication

Thomas Schnalke

Thematic exhibitions on science topics are ubiquitous. From pain to Planck and DNA to Darwin, in Munich, Berlin, Dresden, London, and the rest of the world: Everywhere, smaller or larger presentations dealing with issues of nature, technology and the essentials of human life bloom and blossom. The interest of the attracted audiences seems to continue on and on, thus indicating that these performances don't result from or fuel a momentary fashionable trend. They appear, in fact, to serve a more fundamental need to reassure ourselves about what is going on with us as human beings in our biological, emotional and intellectual condition, in our social and technological surroundings and in our cultural settings. In the light of this rather prominent, broad and intense reception of our actions, it seems rather strange how little we, as responsible museum's representatives, actually think and discuss about what we are doing here, how little we ask and express ourselves explicitly about the essentials, features, politics, potentials, and limits of our specific undertakings: the creation of hopefully outstanding, thrilling, telling, entertaining, sparkling, in the end good thematic exhibitions.[1]

This lack of reflection results to a certain degree from the reputation the making of such exhibitions has in our various academic fields, where we once came from, where we grew up, got initialized, socialized, dogmatized – a reputation we may not really be free to set aside ourselves. "Making exhibitions is not performing research or at least contributing to it!" This is a statement we frequently hear directly from our colleagues, sense implicitly in debates, and sometimes even say or quietly think ourselves. Most members of the academic community are convinced that science and research happens at other places, in labs and archives, but not in exhibition rooms. Thus, planning and realizing exhibitions are regarded as insignificant activities, as something minor. It may be accepted that results of academic analysis are somehow taken into account, but it is generally assumed that the knowledge unfolded in a display comes from elsewhere or from others. According to this understanding, all an exhibition does is to collect, warm up and more or less crudely break down the enlightened products of external academic analysis to be presented to a public that may be interested but is more or less ignorant. Thus, exhibitions are in general defined as something secondary, as "poor relations" to other academic offspring.[2]

The question is whether this attribution is a golden verdict that we have to accept blindly, something, that we just have to live with, around which we are inevitably forced to develop our professional lives in a schizophrenic split between high science and low museum's pop. No! This would be my short and immediate response. I think it is worthwhile to rethink what exhibitions in our cases are, or better, what they could be. The point I want to make is this: thematic exhibitions can be a true scientific format of publication, thus taking on an integral role in the making and performing of research.[3] This format has unique features and qualities and, therefore, also certain

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[1] Concerning the lack of professional reflection see Anke te Heesen's recent efforts to get a substantial discussion started on university collections of scientific objects and exhibitions in the field of the history of science and medicine: te Heesen, Anke, "in medias res. Zur Bedeutung von Universitätssammlungen," *NTM* 16 (2008): 485-490 and "Dem Leben auf der Spur," *NTM* 16 (2008): 522-525.

[2] Concerning the field of medical history in Germany see the methodological survey of Eckart, Wolfgang U., and Robert Jütte, *Medizingeschichte. Eine Einführung* (Cologne and Weimar: Böhlau, 2007) who sketch a material approach but hardly mention the format of an exhibition.

[3] This is, by no means, a new view, but it does not seem to have many promoters; see Teichmann, Jürgen,

strengths and limits. There are, of course, very popular science exhibitions that maintain the utmost distance to any taste of science. But at the other end of the spectrum, why not think, conceptualize and realize presentations in our show-rooms that communicate the outcome of our very own extensive primary research.[4] This is, I know, not an easy thing to do, but surely possible. And if it works, it can have a much greater impact than any article that in the end is read by only five other people in the world.

The core items we are dealing with in each thematic exhibition are objects – things that are not used to show off the author's knowledge or command of the literature, like footnotes in so many books, or illustrations used to "pretty up" an otherwise dry text. I mean that objects must be taken seriously for what they are and what they mean.[5] This is my first crucial point: We ought to take the museum, take exhibitions, take objects seriously, even as objects of research! The material object we are usually dealing with presents a physical body with oddly shaped surfaces. It is a spherical representation of primary functions and secondary attributions acquired through time and space. Thus it has become an epistemic thing, presenting for us a specific source open more or less to be read, hopefully understood, analyzed and discussed by asking for its historical and current meaning.[6] By using it for an exhibition, such an object will finally also find a very distinctive place in the discursive narrative of a spatial presentation. At its very spot within the exhibition room it belongs to or – with others – even constitutes its own specific micro-context, presenting a facet of the overall issue. Reaching out into the space around it, however, each object forms a particle of a larger landscape of contexts. Context is a second basic item to be considered more carefully: Contexts are constructed and made visible with objects in specific rooms along something that you might call a storyline, a scenographic or dramatic plot, or – as mentioned above – a path of discursive narrative.[7]

To underline the addressed issue here, let me emphasize my point focusing on the very space of action. Our objects with their hidden or inscribed texts and information perform in well-defined and designed rooms. Within these highly enhanced and condensed show rooms they never appear alone: each object is embedded in an arrangement of partner objects and is supported by a set of pictorial and textual commentaries. It is vital for every thematic exhibition to develop a unique spatial course, maybe one could even call it an epistemic path, by generating vicinities of objects that thus get in roomly touch with each other, that interact in a stunning, breathtaking

"Populäre Wissenschaft und Wissenschaftsgeschichte in technisch-naturwissenschaftlichen Museen," *Acta Historica Leopoldina* 54 (2008): 655-666.

4 See Schnalke, Thomas, *Natur im Bild* (Erlangen: Universitätsbibliothek, 1995); te Heesen, Anke, ed., *Cut and paste um 1900* (Berlin: Max-Planck-Institute for the History of Science, 2002); Dierig, Sven, and Thomas Schnalke, eds., *Apoll im Labor* (Berlin: Berliner Medizinhistorisches Museum, 2005); Lehmann, Tomas, *Wunderheilung in der Antike* (Oberhausen: Athena, 2006).

5 See Schnalke, Thomas, "Veröffentlichte Körperwelten," *Zeitschrift für medizinische Ethik* 45 (1999): 15-26; Schnalke, Thomas, "Stumme Gesänge," in *Parasiten und Sirenen,* ed. Bernhard G. Dotzler and Henning Schmidgen (Bielefeld: Transcript, 2008).

6 For the epistemic nature of the ‚concrete' in the sciences and of specimens in the fields of biology and medicine see Rheinberger, Hans-Jörg, "Epistemologica: Präparate," in *Dingwelten*, ed. Anke te Heesen and Petra Lutz (Cologne: Böhlau, 2005) and *Epistemologie des Konkreten* (Frankfurt/M.: Suhrkamp, 2006). Concerning the material approach in medical history see respective chapters in Eckart and Jütte, *Medizingeschichte*.

7 See Szeemann, Harald, "Ausstellungen machen," in *Dingwelten*, ed. Anke te Heesen and Petra Lutz (Cologne: Böhlau, 2005); te Heesen, Anke, "Forschung, Lehre, Schau," in *Wissenschaft kommunizieren*, ed. A. Hermannstädter, M. Sonnabend, and C. Weber (Essen: Edition Stifterverband, 2008); Brüning, Jochen, "Inszenierung tut Not!" in *Wissenschaft kommunizieren*, ed. A. Hermannstädter, M. Sonnabend, and C. Weber (Essen: Edition Stifterverband, 2008).

manner that enlightens by confronting, arguing, disputing, commenting, denying, assuring and re-assuring each other.[8]

Our objects simply form our arguments. With their placement in their specific spatial interface we open and display a line, several lines, yes even corridors and veritable environments of argumentation in our exhibitions on which or wherein we move with our streams of thought from A to Z. To make a convincing point in any exhibition, it is essential to develop a core statement in advance, a central hypothesis, something that we see and are absolutely crazy to speak about, to show and make obvious. Otherwise, let's not bother to go through all this stress and hassle of making an exhibition at all.

Drawing a first 'forbidden' analogy, an analogy between text and exhibition, I would like to suggest a parallel between a thematic exhibition and an article we would write for an established academic periodical. Here and there it helps to have a core statement, a central hypothesis, something that is sexy, that thrills us, because we think we have found a facet, an aspect, a relation that tickles us, that seems spectacular to us, never seen this way or in such a light, from such an angle, something that makes it possible and worthwhile to argue about, to integrate into an existing debate or even to open a new field of discussion. Something that, if it is really striking to us, always has to do with us personally, individually, in our current state of being.[9]

Here and there, in a text as well as in an exhibition, we embed this momentum into a sequence of arguments and generate a stream of thought. In an exhibition, our arguments – that is, our objects – are placed in the exhibition room in defined arrangements. These are construed by placing the objects in a certain spatial interrelation, tensely juxtaposed, in intriguing environments and neighborhoods. In these specific context zones our object-arguments are not only displayed, but also commented upon, questioned and sometimes even criticized by supporting or confronting media – pictures, virtual images, legends, et cetera. Let's call the happenings on these little stages of performance – as suggested above – micro-contexts. All together, these micro-contexts or sub-stories constitute the complex macro-context each exhibition wants to or ought to present.[10]

In an article letters, syllables, words, and sentences form a paragraph or a chapter of the text – micro-contexts as well, forming the puzzle pieces of the whole story. One may criticize that the exhibition's landscapes of micro-contexts are much more fragmented, porous, speculative, allowing too many missing links or inducing false associations, and in the worst case, misinterpreting or even presenting highly subjective fantasies. However, each and every written text is quite the same, since there is no text that presents a completely homogeneous layer of arguments, statements or mere information. Texts as well are constructed landscapes of evidence through which the reader can stumble, tripping over certain letters, syllables, words, arguments, ideas – always in danger of losing the path through the lines.

That our audience might get lost in the stream of our thoughts is part of the game, part of the risk, we take when we publish our knowledge. Our hope, of course, is that the recipient – the reader, as well as the visitor – reacts creatively with free and unforeseeable perceptions. Projections and associations can lead to further questions, questions that trigger more studies, more research.

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[8] The importance of the room for arguing with objects can be very well understood by studying the history of arranging anatomical specimens and wax models in collections and museums; see Schnalke, Thomas, "Der expandierte Mensch," in *Medizin, Geschichte und Geschlecht*, ed. F. Stahnisch and F. Steger (Stuttgart: Steiner, 2005)..

[9] The meaning of the author's biographical involvement in choosing, analyzing and writing about specific research topics seems widely accepted. Every scientific exhibition taken seriously, however, contains just as much of the exhibition maker's own life.

[10] See Szeemann, "Ausstellungen machen"; Schnalke, "Stumme Gesänge".

Thus each good thematic exhibition – like a good text – contains the seeds for ongoing research, that is: posing ever more questions...

But what about the dramatic aspect of publicizing the results of our research? In each and every presentation of our issues – our insights, analyses, discussions, and further contemplations – we sense an impulse to perform. As text authors we start with sitting in front of a white page or a blank screen. As exhibition "authors", or makers, we stand in an empty room asking whether it will ever be possible to fill it with our ideas. In these situations we sometimes suffer from quite severe headaches fuelled by deadlines that have long since passed or present themselves in the calendar like the inevitable guillotine. The basic questions here are: How to begin? Where to end? What's the point? What to mention? What to leave out? Further questions are: What thoughts or things (evidence for arguments in the end) match or don't go well together, stand here too isolated, with too large gaps of thought in between, with too crude discursive breaks, inconsistencies, or appear there in too odd or even wrong vicinities with other arguments. Finally, we ask, what thoughts or things have to be revised, replaced, or relocated.

The rethinking in this very moment of inscribing our thoughts on a flat piece of paper or into the space of an exhibition room, is a fundamental act of gaining clarity and really getting straight what we want to say. Maybe this is *the* core element of our academic performance in the process of publication.

Of course, an exhibition is not a text. In fact, to interrupt my analogy for a moment, I would like to state that a thematic presentation in an exhibition room definitely has its very own right to exist, its own specific quality as a format of performance, thus as a format of publication. The obvious and basic difference lies in the dimensions involved. Every written text will always appear on the flat surface of a page. Even the virtual worlds with all their links and hyperlinks present a text on a 2-D screen. Each exhibition, however, displays its topics in the three-dimensional spheres of a specific room.[11] This room can be situated in a museum, an institute, a cathedral, any abandoned building or even outside under the clear blue – or gray! – sky. Its three-dimensionality is its true signature and the ultimate challenge for every maker of an exhibition: to think and argue in a spatial mode, to construe a macro-context from a consistent sequence of micro-contexts within a given, frequently modifiable, but not infinite space, forms the essence of this odd practice. I believe it challenges us to unfold a certain kind of creativity.[12]

Let me suggest a second analogy, an even more forbidden one: Dealing with science objects in 3D-spaces presents certain features that can also be found in exhibitions of the fine arts, especially in art installations. There are many names and a multitude of different environments that may come to mind: From Jason Rhoades to Paul McCarthy, from Bruce Nauman back to Joseph Beuys, they all use or even create specific rooms wherein they place their strange things in an explicit, clearly defined and absolutely irreplaceable position. Every cubic millimeter in these art installations is occupied with meaning, is enhanced, condensed and intensified by its interaction not only among the various things and parts of the installation, but also with the recipient wandering around or sometimes even through it.[13]

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[11] There is a trend to transform or adapt parts of exhibitions for the internet or even create own 'spatial' environments with objects from the history of the sciences in the digital worlds. To underline their very own nature of publication I would like to suggest not calling these realizations "exhibitions", but rather something like "digital presentations".

[12] Maybe there is a gene or at least an acquired – and thus developable – ability to think in three dimensions.

[13] See for instance the exhibitions from the Flick collection with works of Jason Rhoades, Paul McCarthy and Bruce Nauman, as well as the recent retrospective of the work of Joseph Beuys in the Hamburger Bahnhof, Museum für Gegenwart, Berlin; see Blume, Eugen, Joachim Jäger, and Gabriele Knapstein,

Both artists and makers of thematic exhibitions work not only with objects, arrangements and interactions, as well as derived, intended or unintended perspectives, but also quite crucially and most decisively with rooms. During the process of developing concepts for our thematic exhibitions, we frequently go and visit the empty rooms, trying to play around with the objects we have in mind, to see them before our inner eye, seeking to envision how our object environments, our micro-contexts, might fit, might work, might be seen, might induce insights, might provoke further ideas or questions from this angle or that. We stand there, we walk around, we sense what the room tells us, what it offers and excludes.[14]

Under the impression of a given or modified room, we enter an open-ended debate with ourselves and our colleagues about the inner consistency, the moral or ethical legitimacy, but also the freedom and openness of the overall setting of the desired exhibition. This setting should somehow offer our recipients a spatial docking point for their streams of emotions and consciousness so they may be taken further and develop their insights as well as their most colorful associations, projections and fantasies.

Most artists work explicitly with their very own individually reflected subjectivity. On the other hand, they consciously or subconsciously act within a broad culture of many others producing art and within a long history of art. In the mix of external impulses and internal concerns, they plant the seeds for growing their art. But, most important, the fruits of reflection become visible in their art installations as environments, as landscapes of objects, which are also highly affected in their messages and meanings by the very room they are performing in. It is the framework of the space that enables the recipient to grasp the smallest hint behind each art detail, and that also brings everything together to create a whole, hopefully turning it into a convincing piece of art. The installation works if its room works.

As makers of thematic exhibitions, we clearly perform with a good portion of reflected subjectivity as well. As mentioned above, we always develop and ask our questions as researchers from an individual point of view, from within our own biographies, from our unique personal anchor spots in culture, science, and society. In addition, we deal and act, of course, with all that we have taken in, seen, listened to and read in other exhibitions. And so, we finally bring together these external and internal worlds in a creative process of amalgamation. We lay out our insights in exhibition arrangements that at least to some degree can be seen and used as open spaces for reconsideration and review of objects and their internal argumentation in an unpredictable new way that may provoke a creative perception in our colleagues, the interested audience, and ourselves.

Our thematic exhibitions – installations of art? Nice idea! But there seem to be some differences. The artist's final goal is, as far as I can see, to set something free, to place something into the room from within his or her very own sensory system. We are inclined to say: The artist's object is his or her subject, or in other words, the things that we see in an artist's installation are the result of what the artist has already taken in and transformed. These items have been carved, shaped, reshaped, inscribed, and arranged to become something of the artist's self. In short, these things breathe his or her soul. If we as authors of thematic exhibitions would want to act like that, most of us would end, I suspect, like the 'Körperwelten' originator Gunther von Hagens – in the swamps of the banal, of mere kitsch and probably also in an ethical dilemma.[15]

Flick-Collection im Hamburger Bahnhof (Cologne: Dumont, 2004); Blume, Eugen, and Catherine Nichols, *Beuys* (Berlin: Steidl, 2008/9)..

[14] See Szeemann, "Ausstellungen machen"; te Heesen, "Forschung, Lehre, Schau"; Schnalke, Thomas, "Auf Leben und Tod," in *Wissenschaft kommunizieren*, ed. A. Hermannstädter, m. Sonnabend, and C. Weber (Essen: Edition Stifterverband, 2008)..

[15] From the exploding plentitude of literature regarding the so-called Body World's Exhibition, see in a

By contrast, the objects in a science exhibition are or at least ought to remain our object as far as possible. Sure enough, the phenomena surrounding us in culture, science and society that we display as material condensations, also carry something individual from us, especially in the analyses and interpretations we give them. But we limit the degree to which we take these things, internalize, digest, and spit them out again to arrange them as something of our very own. I think we stop at an earlier stage in this process of intellectual digestion.

Secondly, there is also a general difference in the way installations and science exhibitions are displayed. As I said, artists aim to present their highly individual points of view with their installations. The idea (and sometimes also the illusion) in this case is that by re-presenting his or her feelings, thoughts and subjective interpretations, the viewer of the exhibition could somehow step into the mind of the artist, could recognize and understand at least some aspects of the installation as if seen through the artist's eye. In our thematic science exhibitions, we would like to show in a clear, stimulating, and sometimes entertaining way some general aspects of primarily external issues. The "installations" we come up with work on the basis of a more or less commonly accepted didactic mode. Within the sequence of our micro-contexts we unfold our storylines on certain approved semantic paths. We suggest to our visitors a route from A to Z, to take if they choose. So I think there is a slight, maybe in the end only minimal difference: Discursive narrations in a didactic frame displaying a general external topic in our thematic exhibitions versus diving into the subjective realm of an artist's world. And yes, we are not artists, but the making of thematic presentations certainly requires a specific kind of creativity, the ability to argue using objects in a space. In principle, each topic we are dealing with professionally in a conventional text could be put on stage in an exhibition. But we should also ask about possible limits to this format of publication. I think the analogy with texts works quite well when comparing an exhibition and a well-developed article. I definitely have difficulties seeing a parallel between an exhibition and a full-sized monograph. In fact, I frequently find myself saying an exhibition is not a book, because a good book argues too broadly, too encyclopedically, while a good thematic exhibition profits strongly from the one strong core thesis. We know there were and are encyclopedic thematic exhibitions. But let's be honest, which of these "mega-shows" really made a lasting impression, evoked the picture of a Gesamtkunstwerk? Perhaps some individual aspects have stuck in our memory, but they could probably have been worked out much better in a smaller profiled presentation.

There are two practical disadvantages to thematic exhibitions: They cost a lot of time and energy before the opening and they have a restricted life. Let's look at the latter aspect first: Each temporary exhibition is gone after some weeks or months. Every permanent presentation is – or should be – revised after a while, five to ten years. So, what remains are the impressions a certain display has made in the recipients' minds, plus, if we are lucky, the ongoing questioning linked to these perceptions and associations. This, however, happens invisibly as part of a continuous process, the permanent stream of cultural discourse. There certainly are ways of documentation: websites, CDs, DVDs, photographic documentations, catalogues, associated textbooks or specially written articles. These media, however, do not really substitute for the real thing, the impression of the exhibition in its special space. That means we have to accept that an exhibition is a product which will eventually disappear, that it is a format of publication in a lost form, so to speak.[16]

small selection von Hagens, Gunter, and Angelina Whalley, *Körperwelten* (Heidelberg: Institut für Plastination, 2000); Wetz and Tag 2001; Bogusch, Gottfried, Renate Graf, and Thomas Schnalke, *Auf Leben und Tod* (Darmstadt: Steinkopff, 2003); da Fonseca, Liselotte H., and Thomas Kliche, ed., *Verführerische Leichen* (Lengerich: Pabst Science Publ., 2006). Referring to the intense discussion on dealing with human remains in medical collections and museums see Empfehlungen 2003.

[16] One could argue that also texts have a restricted life span according to the regulations and the practices

Everyone who has been crazy enough to realize a thematic exhibition even once knows: Such an enterprise eats up time, energy, physical and mental resources exponentially as the opening date gets closer. In comparison with the routine, well-established, dogmatic ritual of writing and revising tests, each exhibition starts as unforeseeable adventure and frequently puts its protagonists on the tracks of exploding schedules. This is life, one may say, but it is also life time. One can hardly do anything else besides. So it is legitimate to ask what we will get out of it. Let's be honest one last time: Making ambitious thematic exhibitions does not count very much in the academic world. We all think twice about whether we should mention exhibition activities in our professional CVs, whether we should list catalogues or other exhibition-related texts we wrote in our personal academic bibliographies. The making of exhibitions is still not impact relevant.[17] It rarely proves an advantage – in general, I think, it is still seen as a disadvantage – in the process of applying for other academic jobs and climbing the academic career leader. Unless we take this fact to heart and work actively for a change of mentality, this situation will not change. At the moment we cannot really encourage young scholars to become engaged in this field or to try for themselves what it is like to make a thematic exhibition. What would help a bit, I am sure, is to honor thematic exhibitions actively in our fields as true scientific formats of publication.

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[17] There is no review system for academic exhibitions yet.

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Prof. Uwe R. Brückner was born in 1957 in Hersbruck, Bavaria. He is the creative director of ATELIER BRÜCKNER, which had been founded in 1997 after creating the stunning exhibition *Titanic*. Nationally, as well as internationally, he is recognized as a leader in the field of exhibition design. Educated as an architect and stage designer, he is reckoned as a protagonist of scenography. Corresponding to the philosophy "form follows content" he promotes the individual, content-generated design of spatial stagings. Uwe R. Brückner teaches at Tongji University, Shanghai and at the Hochschule für Gestaltung und Kunst in Basel, where he is ranked among the founding directors of the International Scenographer's Festival. He is a member of ICOM Germany, the Art Directors Club for Germany and the D&AD London

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Dr Martha Fleming has been working as an artist, curator, writer and academic in the nexus between science, humanities and the arts for over two decades. She is currently working with the Natural History Museum (London) in the development of their Centre for Arts and Humanities Research, and was Creative Director of the exhibition *Split + Splice* at the Medicinsk Museion (Copenhagen) in 2008-2009. She has exhibited in museums and galleries and made site-specific projects on three continents in New York, Madrid, London and Sao Paulo among others. She has been Artist in Residence at the Science Museum (London) and the Institute of Astronomy of Cambridge University; Senior Research Fellow at the Leeds School of Art, Architecture and Design and at the Materials Library of King's College, London; Development Manager at the Royal Society; founding Trustee of the Dennis Rosen Memorial Trust; and a judge of the Wellcome Trust sciart awards. She has taught in art schools in Canada, the UK and the USA and has both lectured and published widely.

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Walter Hauser studied Physics and Mathematics in Tübingen and Paris and graduated in History of Science. Since 1992 he has been curator for numerous exhibitions, such as *Sonne, Mond und Sterne – Kultur und Natur der Energie* in 1999 for the Internationale Bauausstellung IBA Emscher Park at Zollverein in Essen, or *Climate – the Experiment with Planet Earth* 2002 at the Deutsches Museum. He was since 2001 head of the Center for New Technologies of the Deutsches Museum which opened its permanent exhibitions in 2009. Since 2009 he is the director of the LVR-Industriemuseum, the Rheinisches Landesmuseum für Industrie- und Sozialgeschichte in Oberhausen.

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