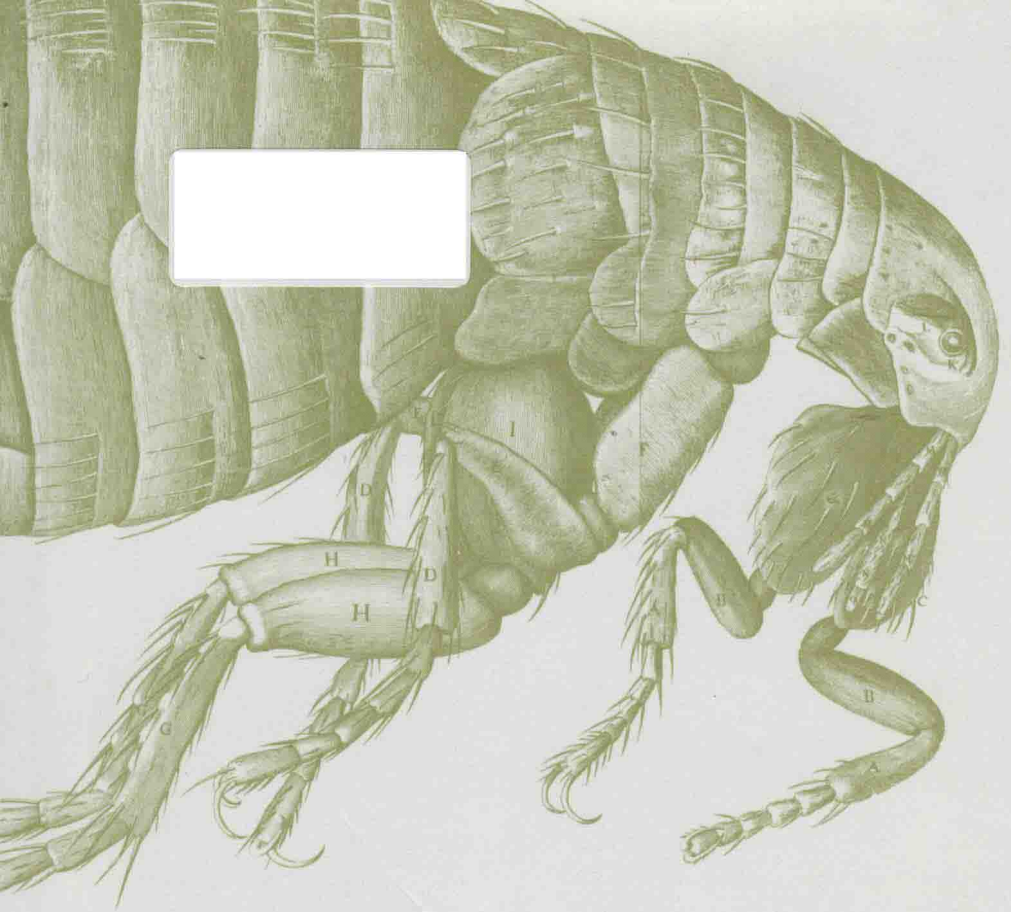
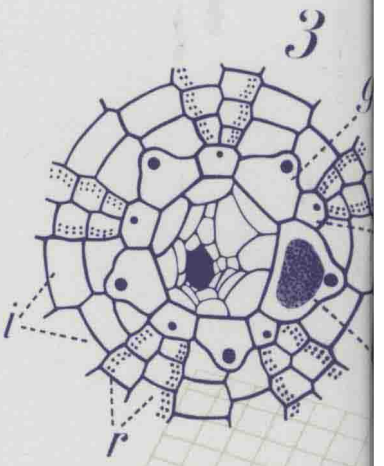
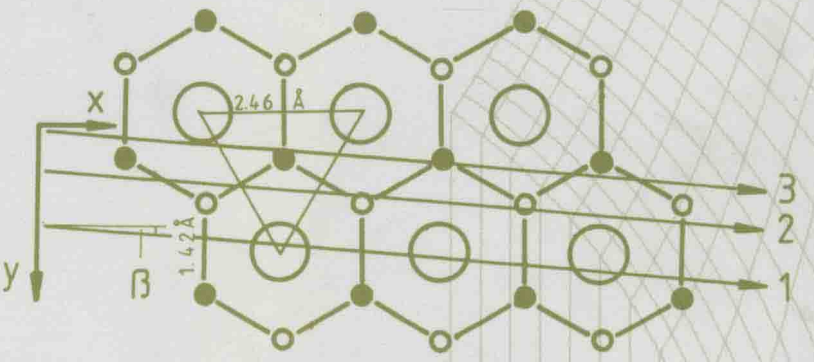




The Technical Image

A History of Styles in Scientific Imagery



Edited by Horst Bredekamp, Vera Dünkel, and Birgit Schneider

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The Technical Image

Foreword
Peter N. Miller

The Technical Image: A History of Styles in Scientific Imagery is a landmark book. It embodies a familiar intellectual format—a book—a project that represents a challenge to the meaning of art history. By discovering in an adjacent field, history of science, a whole range of materials amenable to art-historical treatment, this project points to a new horizon for art history. By making "technical illustration" with its reference point in the world of experiment and observation the arena for this gesture, *Das Technische Bild*, as it is called in German, also models a "cultural history of the material world."

In the German intellectual landscape out of which it sprung around the year 2000, *Das Technische Bild* represented an innovative approach to what Horst Bredekamp and Hans Belting had already offered up as *Bildwissenschaft*, or the study of images. This intervention was inspired by Aby Warburg's catholic approach to images in his practice of art history, something that for Warburg constituted a "cultural-historical art history." The study of Warburg, which emerged in Germany in the 1980s, recovered a voice and a practice that had been silenced not only by his death in 1929 but even more by the subsequent relocation of his institute to London in 1933 and the disruption over the next twelve years of his reading audience. Moreover, those followers who continued his work after him, at the Warburg Institute and elsewhere, did not share all of his aims and in any event did not communicate them to the new English-reading public. Indeed, Warburg's own published writings, let alone the vast manuscript materials in the London-based archive, were not translated into English until 1998 (though they were published in Italian in 1968) and still have not been translated into French.

But in Germany, beginning in the 1970s, the study of Warburg's range of work and his place in the intellectual culture of the early twentieth century has become a richly mined subject. It was here that Bredekamp in particular found an intellectual platform from which he could propose a reorientation of art history. Neither formal nor utterly historicizing, Warburg's "cultural-historical art history" opened up whole realms of images that had never before been treated seriously. Even though art historians were humanists trained to study and interpret images, they had neglected much of what was not considered "art." Like the turn to "visual culture" in the Anglophone world, *Bildwissenschaft* represented a healthy imperialistic grab by art historians, reaching out to occupy the abandoned landscape of advertising images, cheap print, digitalia, and, yes, science, among others.

Das Technische Bild was a research project at the Humboldt University in Berlin starting in 2000, chaired by Bredekamp. It drew together professors and students but also postdoctoral fellows. It launched a fascinating journal in 2003, *Bildwelten des Wissens* (Image-Worlds of Knowledge), and created an intellectual market for intensely visual discussions of practice in the natural sciences. In 2008, a representative sampling of the project's ambition and breadth was published by Akademie Verlag in Berlin. Theoretical statements were juxtaposed to case studies, broad treatments with microhistories. The brilliantly illustrated volume is a joy to contemplate. In turn, parallel and related projects have sprung up in Switzerland and elsewhere in Germany.

This is the book we are translating here and bringing to the wider English-reading audience. We are doing this not only because of its intrinsic worth but precisely because it parallels and challenges ongoing work in English. I have already used the term "visual culture" as an analogue for *Bildwissenschaft*. In fact, their aspirations are very similar. In both cases, though on different foundational grounds, there is a desire to broaden the subject matter of art history from the traditional canon and a willingness to confront the three-dimensionality of the image as well. Hence the otherwise ungainly term "visual and material culture."

At the same time, historians of science, especially those working on early modern Europe, have, from their perspective, also been probing the perimeters of art's history. Paying special attention to the ways in which imagery has been deployed in the context of intellectual argument and social practice, these scholars have slowly but surely been effacing any hard boundary between the verbal and the visual, what otherwise could be termed "content" and "form." The work promoted by Lorraine Daston at the Max Planck Institute for History of Science, originally just down the road from the Art History Department of the Humboldt University where *Das Technische Bild* lives (although today it is further away), has been at the center of this development.

What *Das Technische Bild* brought to this new dialogue between science and art is the insistence that visualization is in itself a technology. Imagery is not passive, not simply an illustration of what is, not simply the corollary of the correspondence theory of truth. Rather, the capability of putting some phenomenon into an image is an interpretative intervention. Indeed, were I to use the more contemporary word *imaging*, we would immediately grasp the technological dimension upon which this research agenda insists. It is this productive power of the image that differentiates the notion of "style" used here from the more passive, almost Hegelian notion of style as a general background, milieu, mentality, or paradigm.

It is at this very moment of burgeoning interest in the intersection of the visual and the material, of art and science, that we feel a translation of *Das Technische Bild* is important. It gives an English-reading public access to a German-language initiative that helps makes sense of the future of art history as well as of art history's relationship to its neighboring disciplines. *The Technical Image* represents the Bard Graduate Center's commitment to the idea that in a global scholarly world it is a necessity to know what is going on in other communities. The best would be for everyone to read everyone else's language. Failing that, translations are necessary. We want

students who do not know German to know about this project because it is important in itself and as a model.

While its origins lie in an argument about broadening art history, even a casual perusal of this volume shows that many technical "images" are also "objects." This volume, then, assumes importance for anyone interested in the future of those disciplines that study objects. Looked at this way, it should be clear why and how a study of the history of technical imagery could also function like a cultural history of the material world.

For the Bard Graduate Center, the publication of this volume marks the conclusion of a collaboration with the Art History Department of the Humboldt University in Berlin, which has involved hosting a visiting professor and lecture series in 2011 and developing a Focus Gallery exhibit in 2012 (*The Islands of Benoit Mandelbrot: Fractals, Chaos, and the Materiality of Thinking*, with a complementary volume published by the Bard Graduate Center and distributed by Yale University Press). All of these projects together emphasize the vast range of what we can learn about the past from its materialized forms.

—Peter N. Miller, Dean, Bard Graduate Center

Contents

INTRODUCTION
The Image—A Cultural Technology: A Research Program for a Critical Analysis of Images

Horst Bredekamp, Vera Dünkel, Birgit Schneider

When the research project "Das Technische Bild" was founded in 2000 as part of the Hermann von Helmholtz-Zentrum für Kulturtechnik at the Humboldt University of Berlin,[1] its focus on the analysis of scientific and technical imagery was a novelty. In the intervening years, several projects and institutions have dedicated themselves to the same field of scientific visual representation;[2] numerous publications document the growing yield of these studies.[3] The project set out from the research hypothesis that the forms of imagery are of no less import than the content and objects they show. Images in the natural sciences are a good example: they do not passively render the findings they serve to represent; they generate and inform them with the distinctive qualities of their own sphere. The transformation of observations, findings, and insights into images partakes actively in the constitution of knowledge. With this active capacity, the production and employment of imagery represent a cultural technique of the first rank. The term "technical" here requires some clarification. For us, it emerged as a fruitful concept because it implies different layers of *techne*. Our objects of study are "technical images" in the sense that they are not artistic, instead primarily originating in the fields of science, technology, and medicine; they are predominantly instrument-based or the results of imaging procedures. On the one hand, "technical" emphasizes the way these specific images are produced (by technical means, apparatuses, instruments, or by hand). On the other hand, images may be thought of as tools or as instruments in their own right. Scientific images thus provide the clearest examples of the technical image's methodological import, but the notion of "the technical image" extends beyond scientific images alone and designates a distinctive and new art-historical approach. The various topics addressed in this volume highlight one or the other reading of the term "technical"; each case study also sheds light on how the different layers of *techne* are interwoven in manifold ways.

From the outset, the project's work has been firmly rooted in the methods of art history; the discipline has built up an unrivaled competence in the analysis of the material features, form, and semantics of images. In this regard our approach differs not only from Anglo-American Visual Culture Studies but also from the collective field of German *Bildwissenschaft*, both of which were developed from a broad field of disciplines.[4] Unlike Visual Culture Studies, we do not first look at the social construction of images but rather at their material form; and unlike the strain of *Bildwissenschaft* rooted in the philosophy of aesthetics,[5] we

1 The project was chaired by Horst Bredekamp until 2012. Its first director was Gabriele Werner, who was succeeded by Matthias Bruhn in 2005, who is also the current chair. The first issue of our yearbook, *Bildwelten des Wissens: Kunsthistorisches Jahrbuch für Bildkritik*, which is published biannually and designed and edited by members of the team, came out in 2003. Having initially relied on funding from the Humboldt University alone, we subsequently received generous third-party funding support from the Getty Foundation, Los Angeles, and the German Research Foundation.

2 In the German-speaking world, we should mention the exemplary work of the Swiss National Center of Competence in Research "Eikones"; the research group "Die Welt als Bild" at the Berlin-Brandenburg Academy of Sciences and Humanities (2005–2008); the Humanities Centre for Advanced Studies "Bildakt und Verkörperung" at the Humboldt University of Berlin; the Research Training Group "Schriftbildlichkeit: Über Materialität, Wahrnehmbarkeit und Operativität von Notationen" at Freie Universität Berlin; the Research Training Group "Sichtbarkeit und Sichtbarmachung: Hybride Formen des Bildwissens" at the University of Potsdam; the Humanities Centre for Advanced Studies "BildEvidenz: Geschichte und Ästhetik" at Freie Universität Berlin; and the Cluster of Excellence "Image Knowledge Gestaltung: An Interdisciplinary Laboratory" at the Humboldt University of Berlin.

3 See, e.g., Bettina Heintz, Jörg Huber, eds., *Mit dem Auge denken: Strategien der Sichtbarmachung in wissenschaftlichen und virtuellen Welten* (Zurich, Vienna, New York: Voldemeer, 2001); David Gugerli, Barbara Orland, eds., *Ganz normale Bilder: Historische Beiträge zur visuellen Herstellung von Selbstverständlichkeit* (Zurich: Chronos, 2002); Martina Heßler, ed., *Konstruierte Sichtbarkeiten: Wissenschafts- und*

follow an inductive and historical approach in the analysis of pictures. *Bildwissenschaft* taken from our perspective originates from art historical traditions.[6] This methodological framework compels the observer to take any visualization seriously as a formal manifestation, delineating its historical context within and without the confines of "art" and going beyond its phenomenological appearance in order to comprehend its modes of operation and specific functions. This approach rests on the assumption that the choice of a particular pictorial form, medium, or type has implications that hide in plain sight and inform the object of study and the manner in which it is studied; Erwin Panofsky used the term "disguised symbolism"[7] to describe this nexus. Moreover, images may trigger new research: the development of genetics as a branch of research, for instance, would have been virtually impossible without the existence of visual representations such as the double helix model and X-ray scattering images. So the ways in which researchers produce and employ images represent more than their conscious intentions, or at least more than their writings and formulas reflect. The project therefore undertakes to investigate the frequently observed constructive agency of images and to determine their intrinsic efficacy.

The goal that "Das Technische Bild" set itself was accordingly to comprehend images not as illustrative representations, but as productive agents and distinctive multi-layered elements of the epistemic process. A particular concern of this investigation is the "principle of disjunction" governing visualization in the natural sciences.[8] This principle seeks to frame the paradoxical observation that a scientific image is often the more thoroughly constructed the more natural its object appears in the rendition.[9] Time and again, technology becomes invisible once its employment becomes a matter of course: by the same token, the artificial character of the image tends to sink into oblivion once researchers begin to work with it.[10] The implication for an understanding of the constructive role scientific images play is that all those conditions that shape the form of an image must be taken into account. The fundamental conviction guiding this critical approach to images is that they must be regarded not as finished products, but with a view to all components of their generation, to the techniques and interventions, the agents who apply them, and the contexts in which they take place: images, that is to say, must be considered in process. The project has accordingly worked from the outset to envision also the traces that have become invisible in the process of rendering something visible. The technologies of image production, in particular, constitute a central element in the study of scientific imagery, as a distinct class of instruments, devices, and tools have been constructed and continually refined that are explicitly designed for the purpose of visualization. This touches upon the enormous significance the act of rendering visible has in the sciences, as well as the technological and media conditions on which knowledge is based.[11] The title of our project refers to this supportive role technological implements play in perception and the generation of images as well as the design and production of images as a more general *techne*.

If scientific images play a constructive role in shaping the findings and insights they illustrate, the representation of an observation in images, however mechanical, however detached from the individual researcher's

Technikbilder seit der Frühen Neuzeit (Munich: Fink, 2006); Inge Hinterwaldner, Markus Buschhaus, *The Picture's Image: Wissenschaftliche Visualisierung als Komposit* (Munich: Fink, 2006); James Elkins, ed., *Visual Practices across the University* (Munich: Fink, 2007).

4 See the bibliography at the end of the book. In the German development of academic disciplines, there is no institutionalized discipline of visual studies or visual culture studies. While there has been a strong tradition of *Bildwissenschaften* in the German-speaking world over the last few decades, today there are still no stand-alone departments for the study of *Bildwissenschaften*.

5 See especially the writings of Klaus Sachs-Hombach, for instance, *Bildwissenschaft zwischen Reflexion und Anwendung* (Cologne: Halem, 2004).

6 Horst Bredekamp, "A Neglected Tradition? Art History as 'Bildwissenschaft,'" *Critical Inquiry* 29, no. 3 (2003): 418–28.

7 Erwin Panofsky, *Early Netherlandish Painting: Its Origins and Character*, 2 vols. (Cambridge, MA: Harvard University Press, 1953). See also Erwin Panofsky, "Probleme der Kunstgeschichte," in *Korrespondenz*, vol. 1: *1910 bis 1936*, ed. Dieter Wuttke (Wiesbaden: Harrassowitz, 2001), 957–64.

8 This concept is borrowed from Erwin Panofsky, who coined the term "principle of disjunction" to describe the disconnect between form and content in the late-medieval reception of antiquity. See Erwin Panofsky, *Renaissance and Renascences in Western Art* (Stockholm: Almqvist & Wiksell, 1960).

9 Horst Bredekamp, Angela Fischel, Birgit Schneider, Gabriele Werner, "Bildwelten des Wissens," in Horst Bredekamp, Gabriele Werner, eds., *Bilder in Prozessen, Bildwelten des Wissens: Kunsthistorisches Jahrbuch für Bildkritik*, vol. 1, no. 1 (Berlin: Akademie, 2003), 15.

10 Hans Blumenberg has proposed this hypothesis, especially in "Lebenswelt und Technisierung unter Aspekten der Phänomenologie," in *Wirklichkeiten, in denen wir leben* (Stuttgart: Reclam, 1993), 7–54. It also underlies the studies contained in the anthologies edited by Heintz, Huber; Gugerli, Orland; and Heßler (see n. 2).

11 Ever since Hans-Jörg Rheinberger and Bruno Latour pointed up this dimen-

choices their appearance may be, likewise becomes an instance of the style of a period, a mindset, a research collective, and a device. Niklas Luhmann's concept of the "medium/form coupling" seeks to capture this process.[12] The reference to "style" in the title of the present book reaffirms the focus on form proposed by Luhmann's argument. It emphasizes that an image not only displays the symptoms and results of a thought style,[13] but also constitutes that style with a quasi-objective power that seems to transcend the work of any individual. The terms "style" and "form" are generally used interchangeably in this volume. We favor "form" as the more neutral and general term of analysis that avoids the historic connotations of "style," which, in the nineteenth century, implied a value judgment. In its wider sense, however, "style" reveals the art historian's assumption that form always implies a symbolic meaning.

The desire for historical order tends to subsume phenomena under concepts, which then become the paradigms of epistemic progress. *Objectivity*, *documentation*, and *evidence* are exemplary concepts that, as the scholarly study of scientific images has thrived, have become so popular and influential that the material has seemed to submit of its own accord to the order they delineate. "Das Technische Bild," however, takes the inverse route; our phenomenological-conceptual spindle always moves upward from the pictorial forms and techniques. This inductive method, which is the standard in archaeology and art history, is particularly apt for demonstrating the extraordinary power that forms of scientific imagery wield. We have found that this perspective provides better insight into how the initial search for suitable visual forms, which is often a process of trial and error, as well as the conventionalization of pictorial forms proceeds. The meticulous study of forms accordingly constitutes the point of departure as well as the final destination of all our analyses of imagery.

Manifesting perceptions, observations, and insights as well as giving them definite shape, images must in a second step be examined in the interdisciplinary perspective that is an indispensable part of art-historical iconology.[14] That is particularly true of the wide range of scientific imagery, and implies the involvement of methods of inquiring into the constructive character of any emerging pictorial form. In consequence, the iconological interpretation of technical images also requires the application of methods and findings from cultural and media studies, anthropology, sociology, and political science; vital, in particular, are the contributions of the history of science and technology studies, with which our endeavor has in recent years built a positively symbiotic relationship.[15] Approaches in aesthetics and the philosophy of consciousness that promise to overcome the Platonism of some analytical philosophy seem to adumbrate another new horizon of collaboration.[16] Based on image-specific analyses, only this polyphony of methods can give an adequate account of the constructedness, mutability, and operability of these images. Accordingly, our team, and the group of contributors to the present volume, includes not only art historians, but also cultural and literary scholars, physicists, philosophers, and historians of science.

In order to trace the evolution of our project since 2000, the present book lays out our findings in conjunction with the full range of our approaches; we hope that it may serve as a textbook of methodology. The

sion, many scholars have emphasized the foundational role that technical and scientific images play by rendering phenomena visible.

12 Niklas Luhmann, *Art as a Social System*, trans. Eva M. Knodt (Stanford, CA: Stanford University Press, 2000), 102–32; and cf. Niklas Luhmann, *Die Gesellschaft der Gesellschaft* (Frankfurt a.M.: Suhrkamp, 1997), 195–202.

13 Ludwik Fleck coined the term "thought style" to describe the system of conventions, agreements, and procedures that, transcending the ideas of any individual researcher, governs the scientific practice of a research collective. See Ludwik Fleck, *Genesis and Development of a Scientific Fact* [1935], trans. Fred Bradley, Thaddeus J. Trenn (Chicago, London: University of Chicago Press, 1979).

14 As early as 1912, Warburg mentioned "iconological analysis" as an "extension of the methodological borders of our study of art, in both material and spatial terms." Aby Warburg, "Italian Art and International Astrology in the Palazzo Schifanoia, Ferrara" [1912], in *The Renewal of Pagan Antiquity: Contributions to the Cultural History of the European Renaissance*, ed. Steven Lindberg (Los Angeles: Getty Publications, 1999), 585.

15 See the exemplary study by Lorraine Daston, *Eine kurze Geschichte der wissenschaftlichen Aufmerksamkeit* (Munich: C. F. von Siemens Stiftung, 2001); Wolfgang Lefèvre, Jürgen Renn, Urs Schoepflin, eds., *The Power of Images in Early Modern Science* (Basel: Birkhäuser, 2003); Wolfgang Lefèvre, ed., *Picturing Machines 1400–1700* (Cambridge, MA: MIT Press, 2004). Many of the contributors to the yearbook *Bildwelten des Wissens* are likewise historians of science.

16 See, e.g., John Michael Krois, "Für Bilder braucht man keine Augen. Zur Verkörperungstheorie des Ikonischen," in John Michael Krois, Norbert Meuter, eds., *Kulturelle Existenz und symbolische Form: Philosophische Essays zu Kultur und Medien* (Berlin: Parerga, 2006), 167–90; Sybille Krämer, "Operationsraum Schrift: Ein Perspektivenwechsel im Schriftverständnis," in Gernot Grube, Werner Kogge, Sybille Krämer, eds., *Schrift: Kulturtechnik zwischen Auge, Hand und Maschine* (Munich: Fink, 2005), 13–32; Frederik Stjernfelt, *Diagrammatology: An Investigation on the Borderlines of Phenomenology, Ontology and Semiotics* (Dordrecht: Springer, 2007); Wolfram Hogrebe, *Echo des*

Nichtwissens (Berlin: Akademie, 2006); Martin Seel, *Ästhetik des Erscheinens* (Munich: Hanser, 2000); Lambert Wiesing, *Artifizielle Präsenz: Studien zur Philosophie des Bildes* (Frankfurt a.M.: Suhrkamp, 2005).

core of the book consists of several historical case studies. They evolved out of individual research projects that have been undertaken at the institute since its inception. Each case study presents a larger constellation of issues in a limited set of specific images. Four methodological articles precede the section of case studies that introduce the reader to the set of questions we study, embedding them in a more general framework. For the English edition, Franziska Brons, Stefan Ditzen, and Reinhard Wendler provided new case studies, while Matthias Bruhn and Gabriele Werner revised and updated their methodological articles. The case studies also form the basis for brief encyclopedia-style definitions interspersed throughout the book. The selection does not aim at lexicological completeness; rather, it highlights specific features and dimensions of scientific and technical imagery and reflects on the particular challenges these features pose. They define, and elaborate on, selected terms that have in recent years become key concepts in the analysis of scientific imagery. For example, the terms "image noise," "observation techniques," and "visuality, visualizing, imaging" bring fields of inquiry and functions of imagery into focus that are of particular significance to scientific images insofar as they allow us to take into account the ways instruments condition them and their embeddedness in generative processes. Terms such as "diagrammatics" and "structuring images as tableaux" refer to species and configurations of images that are of strategic value in the presentation of scientific and technological material. "Comparison as method" and "iconological analysis" represent our attempts to examine the significance and application of art-historical methods in the realm of scientific imagery. These articles hope to provide analytical tools to scholars of scientific images and chart avenues of future inquiry. They muster different concepts from the discipline that may be made fruitful for a further analysis of technical images.

The thematically arranged bibliographical appendix surveys the essential research in the field of scientific imagery. We have sought to adapt the bibliography for an English-speaking audience, but know full well that the result of our efforts may not be comprehensive. In light of the fact that defining and appreciating the intrinsic value of historic materials requires that the present-day interest in them has been rendered visible—and can thus be considered from a distance—the case studies following the four general essays form a sequence moving backward from the present into the historical past. This arrangement parallels the organization of our yearbook, *Bildwelten des Wissens*.[17]

17 The prototype of this organization is Dietrich Mahnke's history of cosmology, which also begins with the present and then proceeds to rewind the history of astronomical models. See Dietrich Mahnke, *Unendliche Sphäre und Allmittelpunkt* (Halle a.S.: Frommann, 1937).

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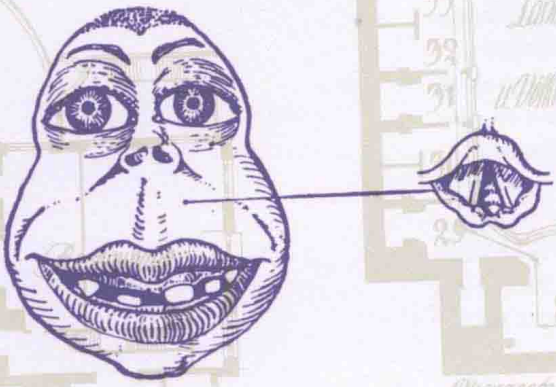

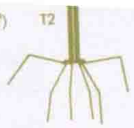

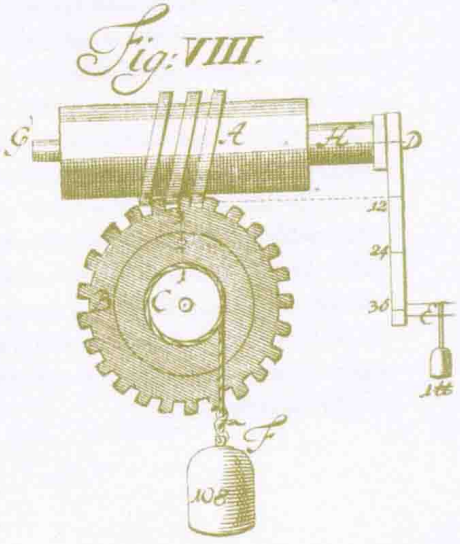

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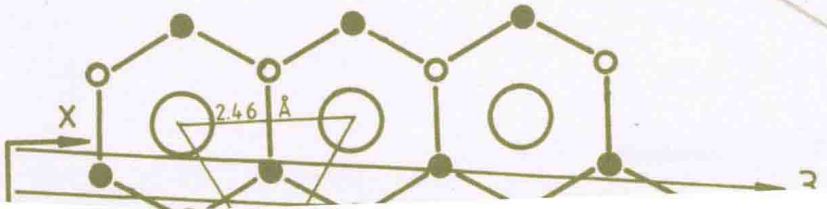
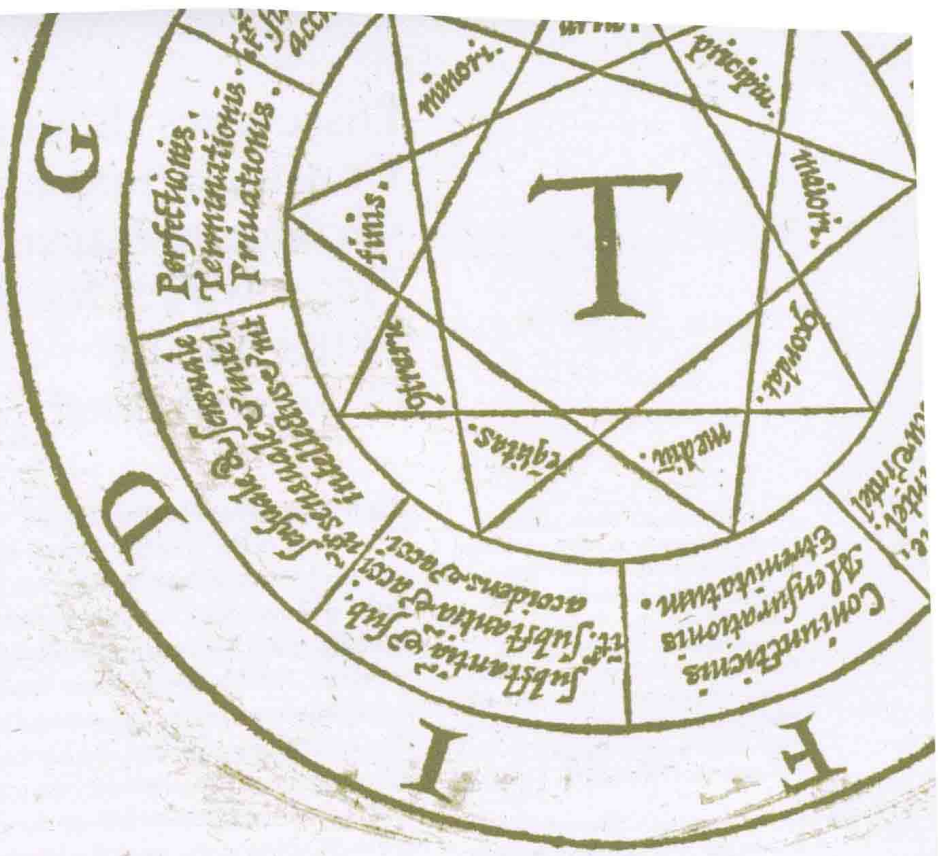




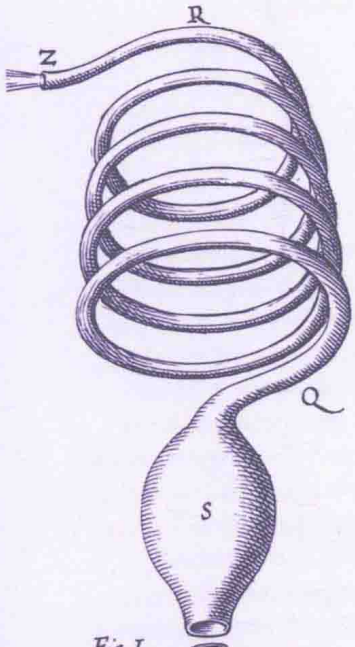
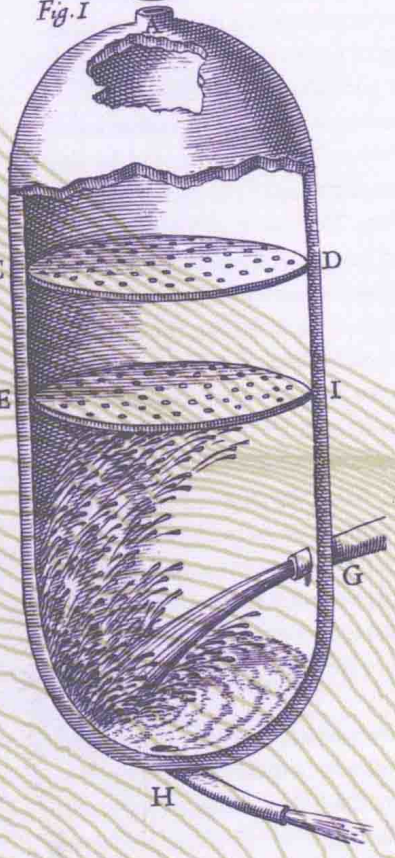


Fig. I



Methods