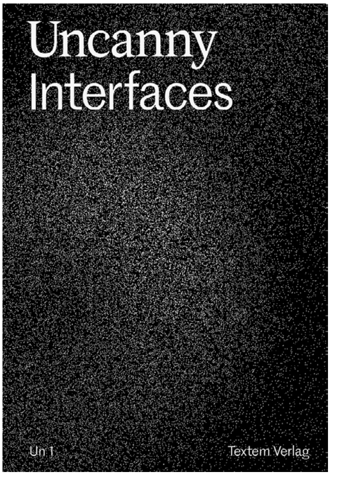
Seeing as Cutting – A "Tomological" Concept of Vision

Matthias Bruhn



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Kryographic imaging: The frozen bodies of Wilhelm Braune in Leipzig

In 1860 Christian Wilhelm Braune, a German surgeon, was appointed Professor for Military Medicine and Topographical Anatomy at the University of Leipzig, a post he kept until his death in 1892.[1] Only a few years after his appointment, he was internationally acclaimed for a publication with a somewhat intimidating title, the *Atlas of topographical anatomy: after plane sections of frozen bodies*, in German *gefrorene Cadaver*.[2] When the remarkable, high-quality book appeared in 1867, Leipzig was one of the leading places for medical studies in the German-speaking countries and also a world capital for printing.

Braune's Atlas was meant to be his masterpiece. Although recent beholders may find its color plates quite common – as they seem to show nothing more than cross sections of human bodies – they were revolutionary at the time they were issued. For what seems to be a traditional or even schematic representation of human anatomy was the result of a demanding and merciless technical operation. Braune had corpses of young deceased persons completely frozen (e. g. the body a 21-year-old male in fig. 1), then

1 Notes on Braune's life are provided in German by Hermann Wunder (1892, pp. 41), Wilhelm Krause (1903, pp. 206–209), and Paul Diepgen (1955); the Leipzig University Archive holds a few documents concerning Braune's life and work.

2 Braune 1867–1872

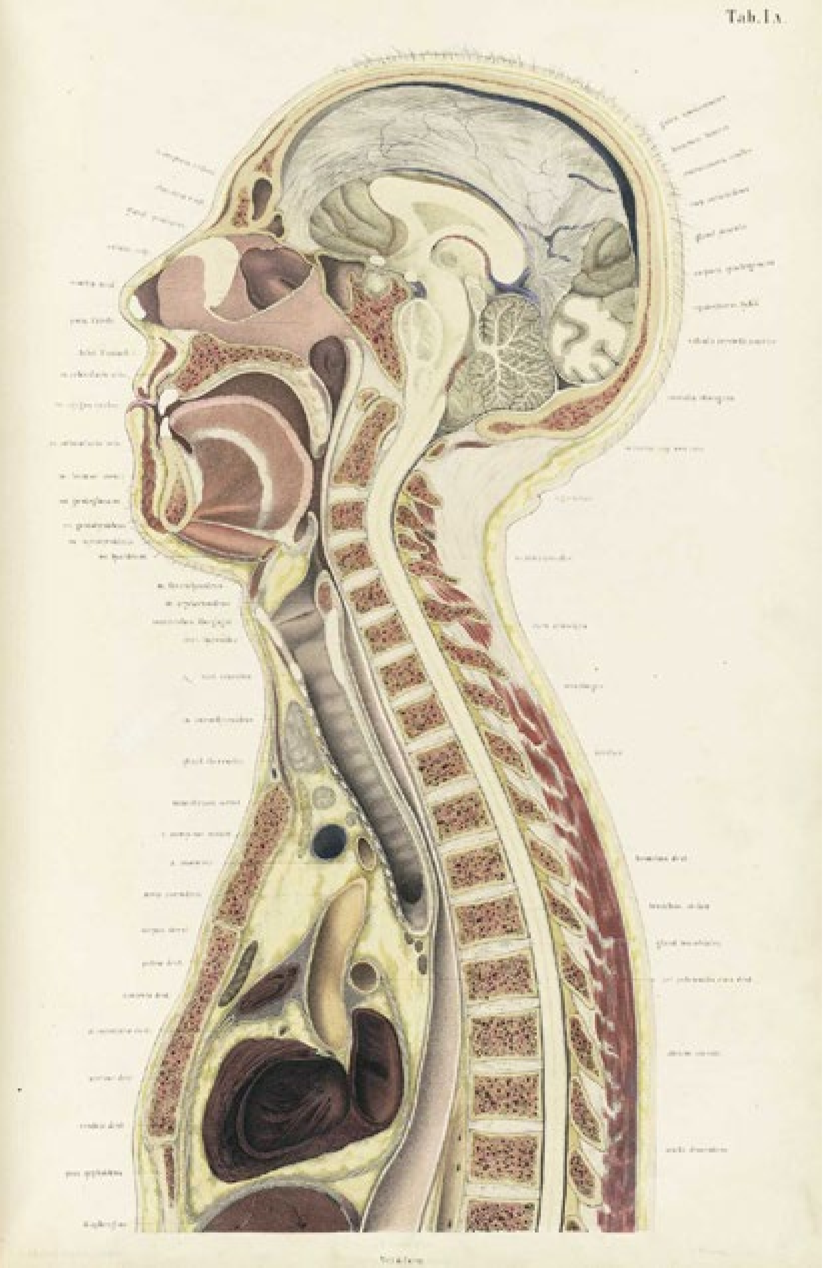

Fig. 1: Wilhelm Braune: Cross section of a male human body, aged 21. Lithography from “Topographisch-anatomischer Atlas nach Durchschnitten an gefrornen Cadavern”, Leipzig 1867, tav. X.

sagittally and frontally divided with huge saws like wooden logs. In a next step, the frozen halves were manually drawn by professional illustrators who then handed the drawings over to a lithographer.

The atlas cuts the body into slices or layers that can be clearly distinguished and counted. In line with established anatomical practices,[3] every phase of preparation and dissection was documented in a detailed protocol that was later included in the printed work:

> "The corpse, which arrived unfrozen, was placed on a horizontal board without any support for the head; it was only taken care that members lay as closely as possible along the midline. The body was left in this position outside the building for 14 days at a temperature of about minus 8 degrees Réamur (i.e. minus 10 degrees centigrade or 14 degrees Fahrenheit). After this time, it was completely frozen. The middle line of the front and back of the body was marked with a black string and then divided with the pad saw, like two carpenters cut a tree freehand. [...] After cleaning of the right part the cut prove to be very felicitous. [...] So a drawing was traced on the frozen preparation and slowly completed after the body had defrosted."[4]

The short quotation reveals a number of factors that had to be considered by the anatomist. First, it shows the demand for extreme exterior temperatures, as modern kryotechniques were not yet available to make Braune completely independent from cold weather periods.[5] Second, it underlines that the drawings taken are more than mere copies, as they are executed in consecutive steps in order to obtain an anatomically correct depiction of the bodies.

Visitors might have been shocked, had they entered the working hall of Braune without warning: Cutting though the body of a pregnant woman, he presented the corpse once with the fetus and one time without it, while on another plate this fetus is being shown like a baby lying on its stomach, although it is only one half of it. But specialists took it differently. A short biographical note reports that Braune's work was characterized "by the diligent, systematic direction of saw-cuts, by truth to nature, and artistic elegance, so that his illustrations may rank among the most instructive", while the images of his predecessors Pirogov and Le Gendre remained "mysterious" and "fuzzy".[6] As a matter of fact, Braune intended to display clear and readable images that would avoid any ambiguity and excel

3 Cf. Hoffmann 2008, pp. 153–195. Also cf. the ERC funded research project on "paper technologies", directed by Volker Hess, Freie Universität Berlin.

4 Braune 1867, p. 1

5 „Braune experimentierte zudem mit verschiedenen künstlichen Kältemischungen, um unabhängig von länger anhaltenden Kälteperioden makroskopische Gefrierschnitte anfertigen zu können" (Heidelberg University Library 2013).

6 „[...] durch die sorgfältige, systematische Führung der Sägeschnitte, die Naturtreue und künstlerische Eleganz aus[gezeichnet sei], so daß seine Abbildungen zu den am meisten instructiven zu rechnen sind" (Krause 1903, p. 208).

the first publications by Nicolai I. Pirogov (1853) and Eugène Quintien Le Gendre (1858) who had also experimented with cross-sections of frozen bodies.[7]

On the other hand, he completely neglects the individual contribution and manual work of the employed artists, as the names of Hauptvogel and Schmiedel (the draughtsman and the lithographer) are mentioned nowhere in the text or the imprint but appear on the lower margin of the plates alone. Despite the fact that they contributed also to several other works, they are not even listed in any medical or art historical bio-bibliography.[8] This was clearly in line with contemporary ideas of a "mechanical" objectivity which took images as almost automatic representations of nature if executed by well-trained and technically equipped illustrators laboring like machines (in a certain way like their colleagues in anatomy and surgery).[9]

As an extensive obituary in a British medical journal indicates, Braune's Atlas became well-known among international surgeons although or because the way it displayed the body was uncommon.[10] But why would someone need a sagittal cut through an entire body that looks like sliced by a huge guillotine, or cross sections of the organs of a particular individual? The violent dissection of the body is not only a symbol for the dialectic of knowledge in a general sense, the Atlas is also the product of an industrialized curiosity in the era of modernization, national competition and increased military research: In view of the tremendous losses of lives during the Napoleonic wars, Otto von Bismarck's politics of expanding the Prussian State were strategically aligned at a step-by-step incorporation of territories, commencing with the war against Denmark in 1864. Braune took part in all those campaigns as a volunteer of the Saxon army, visited military hospitals and studied the various injuries and mutilations of soldiers, as did his colleagues in other European countries.

Against the historical backdrop, also Braune's research can be seen as an interface between medical, military, and industrial interests, all of which claim a systematic control over life and death. He was appointed physician-general in 1870. The final volume of his Atlas appeared right after the declaration of the second Reich in Versailles. Soon Braune became an expert sought after for the new

7 Pirogov 1853; Le Gendre 1858

8 They are neither mentioned in Edgar Goldschmid's "History of pathological illustration" (1925) nor Schulze's: „Nulla dies sine linea. Universitärer Zeichenunterricht – eine problemgeschichtliche Studie" (2004) that includes a complete directory of university illustrators in Germany. Unfortunately, the correspondence between Braune, his illustrators and publisher seems to be lost. Veit & Comp Leipzig was later taken over by Walter De Gruyter, the historic archive of which is now in the Staatsbibliothek Berlin (Dep. 42 [Walter de Gruyter], 1749–1945).

9 On "mechanical objectivity" see Daston, Galison 2008. In printing, the preparatory copy or lithograph can also be called a mechanical. In the early 20th century, illustrator Max Broedel (1870–1941), who emigrated from Leipzig to Baltimore, founded the Department of Art as Applied to Medicine and became one of the most influential medical drawing teachers in the U.S. He signed his coal drawings as autonomous art works and this was later adopted by most of his students.

10 British Medical Journal 1892

field of biomechanics. Fascinated by the idea that motion could be geometrically described and simulated, he began collaborating with the mathematician Otto Fischer.[11] In some respects, this collaboration preceded the studies of human and animal locomotion by Marey, Muybridge and Gilbreth, and may also be seen as a background of Ernst Mach's series of photographs that were made to understand the reason for heavy wounds among soldiers caused by small fire-arm ammunition, leading Mach to the discovery of the acoustic pressure preceding projectiles.[12]

On the other hand, while the latter focused on a photographic dissection of locomotion made possible by short-time exposure, Braune remained mostly interested in spatial relations. "Topographical Anatomy", his area of expertise, implied the full knowledge of the body's blueprint, needed for the practical reasons of surgery.

The virtue of sectioning across

In contrast to pictures showing aspects or outlines of an object, cross sections strike and operate transversally against the interior structures, unveiling invisible spaces and fascinating patterns the function of which remains a secret and needs to be interpreted. This is one of the reasons why the opening of bodies, as a microcosmic mirror of the world, could be used as a prognostic means of fortune-telling, in the hope that quick intervention may produce spontaneous images capturing the will of the gods. In contrast to other modes of representation transposing their object to a different level of observation (like a shadow projection does by reducing a body to a silhouette), the procedure is usually destructive or, in the case of living organisms, lethal.

But also, a corpse is a precious body that has to be handled with care. In anatomy, every step of dissection is thus executed according to standard procedures which are traded over generations in spoken and written language. As medicine and surgery were two different professions, the first being a science and the second often a business of warfare. Physicians were to overcome not only fears of contagion or religious reservations, they also had to deal with the technical issues like cooling and decay.[13] Even the medical revolution heralded by the *Seven books on the human body's fabric* (*De humana corporis fabrica libri septem*), published in Basel in 1543 by the ambitious surgeon Andreas Vesal, relied on the knowledge that anatomy is a destructive practice. On the other hand, he saw it as a genuine form of research beyond the academic rituals of dissection because it opened up knowledge about the human being and thereby dignified the body dissected. In this respect, Vesal dissociated

11 On Braune's collaboration with Fischer see Diepgen 1955, p. 88. Paul Diepgen (1878–1966) had been a student of Braune in Leipzig. The exhibition catalog "+ultra. knowledge & gestaltung" (Doll, Bredekamp, Schäffner 2017) reproduces models made by Braune for the simulation of human motion.

12 In addition to the ample literature on animal locomotion, chrono-photography and Etienne-Jules Marey's graphic method also cf. Mayer 2013. On Ernst Mach see Hoffmann, Berz 2001.

13 French 1999, pp. 193 ff.

Fig. 2: Charles Estienne: Anatomy of the male human body. Woodcut from "De dissectione partium corporis humani libri tres", Paris 1545, p. 242; fig. 9b.

himself from teacher Johann Winter who still defended the medieval separation of lecture and demonstration in anatomy, despite the fact that he already supported the idea of personal examination that Vesal later promoted.

In this context, pictures were a decisive agent for overcoming the notion of surgery as a brutal and simplistic practice to be executed under the supervision of a medical doctor; in combination with the success of book printing, this fostered new ways of depicting the human, three-dimensional body on a page.[14] Vesal has thus invested more than anyone before him in the choice of capable artists and the aesthetic quality of pictures, now mostly attributed to Titian's alleged pupil Stephan van Calcar. Following Vesal's example, other anatomists continued to refine and vary his modes of envisioning the body, like the atlas of Charles Estienne from 1545 that is apparently indebted to the Flemish surgeon.[15]

Estienne's cross-section of the human skull, e. g. (fig. 2), becoming a recurrent motif in the early modern atlases, is remarkable in that it requires a complex procedure to cut both through the hard bone and the brain's soft tissue, without completely destroying such structures. In Estienne's case, the cross section of the head of a naked man also marks the forefront of the image. The open skull in his plate is directed towards the reader as if to approach him with a clean, transparent, bloodless vision of a skull and brain that can be looked at like through a pane of glass. In those particular areas the body suddenly turns into a ground plan, while hatchings, colors and shadows still represent structures and borders. Structures are thus at the same time destroyed and translated, put into effect by a distinct depiction in woodcut or copper. But instead of offering a mere "diagram" of anatomical detail, the medium itself is a layer that becomes visible only when it cuts through the flesh. The image transcends the division of body and picture, as conceived in Maurice Merleau-Ponty's *The visible and the invisible*, and replaces the blade.[16] It is neither projected nor printed, woven or molded, but intersects with the body, virtually becomes the section itself. Ideally, the sharpness of the blade and the sharpness of vision intersect.

The fact that anatomical and surgical procedures were to a large degree formalized may also have contributed to the idea that the dissected corpse resembled a body of machinery that can be dismantled and comprehended, like in an act of retro-engineering. Flap-prints like the male and female anatomies made after designs by Heinrich Vogtherr in 1538 have been sold during the 16th century as colorful, multi-layer prints that combine the intact, spatial and

14 For a historical overview see Choulant 1962 [1852]; Goldschmid 1925; Herrlinger, Putscher 1967/1972; Lyons, Petrucelli 1987; Roberts, Tomlinson 1992; Kemp, Wallace 2000. Cf. the virtual exhibition "Dream Anatomy" at www.nlm.nih.gov/exhibition/historicalanatomies/browse.html (accessed 5/2018) and the collection of 19th century medical atlases at Heidelberg University Library (www.ub.uni-heidelberg.de/helios/digi/anatomie/Welcome.html (accessed 5/2015)).

15 Estienne 1545

16 Merleau-Ponty 1968

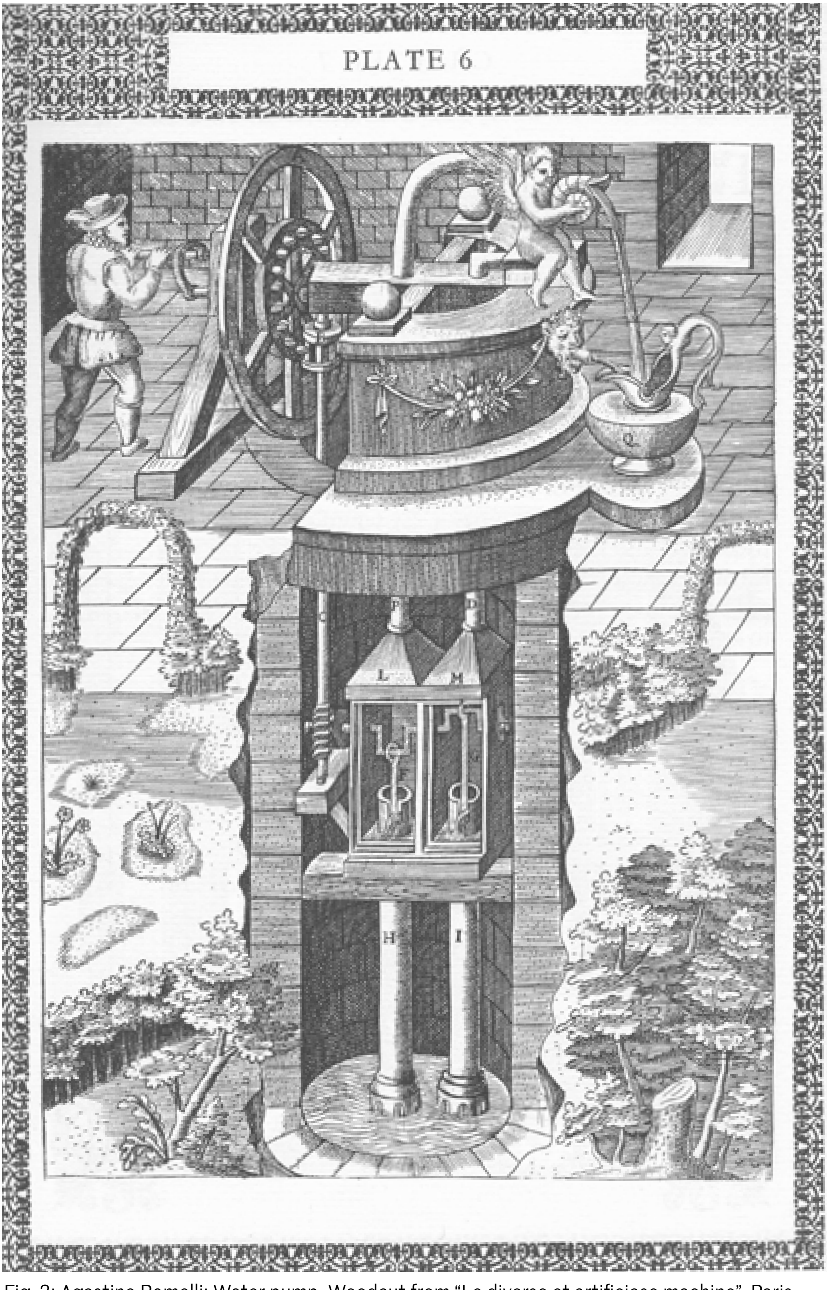

Fig. 3: Agostino Ramelli: Water pump. Woodcut from “Le diverse et artificiose machine”, Paris 1588, plate 6.

living body with flexible dissections.[17] At this point in history, the idea of the *fabbrica* of the human body is also translated into the notion of a factory. Both cross-section and paper-instruments turn the human into an apparatus. In return, engineers and geologists like George Agricola[18] or Agostino Ramelli[19] adopted the idea of pictorial incision for the representation of pumps, chambers, and other closed constructions (fig. 3). In consequence, cross sections became common for displaying the complicated interior of all kinds of bodies, ranging from fortifications to Noah's Arc. Jacques de Vaucanson's engraving of a Digesting Duck from 1739, La Mettrie's mechanistic description of the human as a machine (L'homme machine) in 1748, or Fritz Kahn's famous colour lithograph of a *Man as Industrial Palace* of 1926 and a plethora of similar technical depictions prove that the organic world continues to be comprehended as an automaton or factory.

Cutting a stone or splitting along a piece of wood revealed miraculous grains, figures and colors, like in Francesco Stelluti's treatise on fossil woods of 1637. Even if the forms created and the new perspectives offered by this act were the result of mere chance, tomographical vision thereby became epistemologically indispensable in almost every scientific and technical field. Since the origin or growth of minerals and fossils was still unexplained in the 17th century, but seemed to be connected with the activity of the earth, the technique of clean-cut, polished, colorful mineralogical sections also inspired a particular method called geognosis by the German mineralogist Abraham Gottlob Werner (1749–1817), in analogy to medical diagnosis.[20] Geognosis described the detection of geological deformations by mapping different types of minerals to be interpreted as "symptoms" of hidden processes, e. g. volcanism.

Another means to explore the subterranean world was provided by stratigraphy, also a variant of cross-sectional representation.[21] Such diagrams scale up the veins of a stone or the geological phenomenon of the outcrop (in English sometimes called picture) to the structure of entire landscapes or the earth as a whole, but despite such rootedness in macroscopic experiences, the stratigraphical image is a mostly artificial and imaginary one. Early examples were produced by Swiss natural historian Johann Jakob Scheuchzer who intended to depict the Alps cut at length like an anthill, a model that was adopted by other geologists like John Strachey in 1715 for the English countryside (fig. 4), or the Italian Antonio Vallisnieri a few years. In connection with theories of natural catastrophes and political revolution, stratigraphy also led to concepts of social stratification.

17 Cf. Dackerman 2011, p. 70 f.; Carlino 1999

18 Agricola 1556

19 Ramelli 1588

20 Cf. Stafford 1994, for the concept of diagnosis / geognosis. Hamilton's example is reproduced in Stafford 1999, p. 37.

21 Rudwick 1976, pp. 149–195; Keller 1998; Schnapp 1996. For Strachey cf. Young, Stearle 2008. Also see Tomalino 2011.

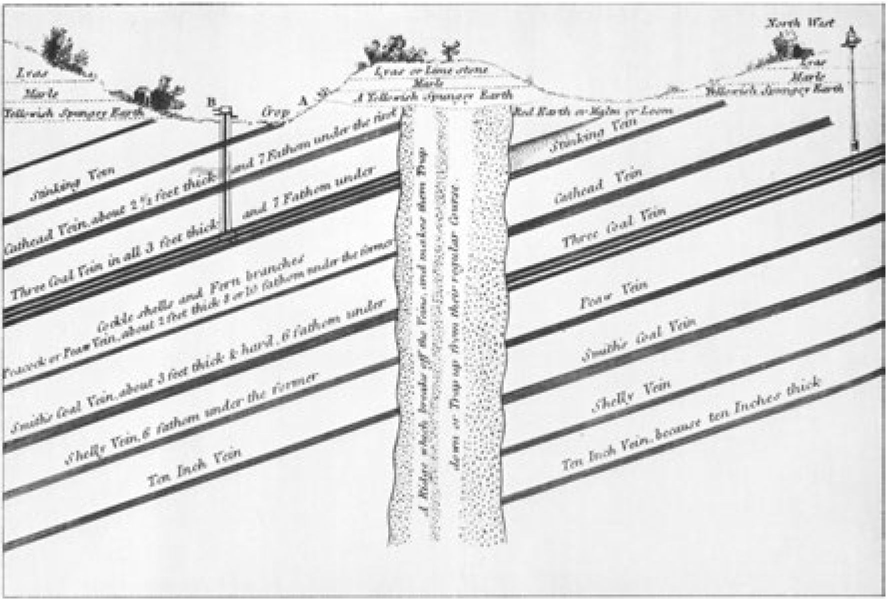

Fig. 4: John Strachey: Coal Strata. Copper print from his "Observations on the Strata in the Somersetshire Coal Fields" (Philosophical Transactions of the Royal Society of London, 1719, p. 972).

The manifold products of cross-sections that can be found in the arts and sciences add up to a visual history one might describe with the neologism *tomological* that includes practices as well as visualizations – which is why "cross section" has also become the name for a style of depiction. As late as around 1800, almost everything from eyeballs to kidney stones is cut across, collected, and displayed in medical iconographies, as if they were ancient gems.[22] French physician Xavier Bichat applied cross sectioning to different body tissues, a method thus called Histology. It emerged at a time when processes of life and death receive increased attention and the discipline of "biology" was given its name. Histology helped identify the composition of organs and the causes of diseases and death by characteristic patterns and states of decomposition. In combination with microscopy (which Bichat was not in favor of), it was to become the fundament for new disciplines such as nosology, pathology and forensic medicine in the course of the 19th century.

The knowledge of structures revealed by cross section remained a fundament of the modern sciences and an inexhaustible source of artistic inspiration, be it in William Hamilton's collection of Vesuvio stones from 1776 or in Roger Callois' book on the *Writing*

22 A similar "tomological" approach seems to be the pattern behind a series of short films produced by Italian artist-director Yuri Ancarani in 2012 who dedicated two of the films to the Carrara marble quarries and the robotic surgery system *DaVinci*.

of Stones two centuries later.[23] Respective objects and phenomena were systematically collected, prominently displayed (e. g. in furniture) and reproduced in lavishly illustrated books.

Getting closer to the seams of life

Anatomic vision has thereby produced a further, alternative mode of vision that is neither depending on linear perspective nor produced by impressions or casts. The system space that art historian Panofsky had called the geometrically arranged pictorial space of the Renaissance is transformed into a system pane, an interface (or German Schnittstelle) that includes visible structures of the depicted body. In contrast to the image as a theoretical section through the rays of vision, like in Albrecht Dürer's well-known illustration for his 1525 treatise on measurement (where a woman is depicted by a male draughtsman), the body is cut into real pieces for a purpose. Medical treatises, for instance, were also made to emotionally prepare prospective doctors in the fields of Obstetrics and Gynecology that emerged in the 18th century.[24] In the famous example of William Hunter, published in 1774, the drawings of Jan van Riemsdyk were reproduced in large-scale copper prints.[25] Today's viewers can still be shocked by the cruelty of a pregnant abdomen cut open; yet in a certain way, the chopping of the upper legs might seem even more sexualized or sadistic in that it does not add anything to understanding the birth process.[26] It could be taken as a hint for the beholder that vision requires cold destruction, with a picture plane working like a blade.

Surgery remains a mechanical profession. In order to release spirits and pressures, heads are being opened with drills and hammers, inflamed limbs are amputated with saws. Without sedatives and anaesthetics, such operations turn into torture and martyrdom. The set of instruments that Andreas Vesal displays in his anatomy (fig. 5) still resemble the workbench of a butcher or a cook and can be clearly distinguished from the elegant 17th century toolset of a barber-physician preserved in the Pomeranian art cabinet (fig. 6). On the other hand, progress in medicine, pharmacology or technology should not mislead to the assumption that refined instruments are the product of modern industry nor should they suggest that mechanization would be a solution for every problem in visualization.

First, the simple splitting of stones can still create edges sharper than any modern metal blade. Humans learned to use them for operations like food preparation just like they learned to control fire or water. Because of their definite force, knives and swords became the ultimate symbol for legal or military power, for punishment or

23 Caillois 1985; for the role of stones in art also cf. the contribution by Claudia Blümle for Doll 2017.

24 See Donegan 1978; Arons 1994; Ehrenreich, English 2010

25 For the prints executed by Robert Strange see e.g. Roberts, Tomlinson 1992. On 18th century sections in general also Stukenbrock 2003.

26 Cf. Jordanova 1989; Didi-Huberman 1999

Fig. 5: Andreas Vesalius: The surgeon’s tools. Woodcut from “De Humani corporis fabrica libri septem”, Basel 1543, p. 235.

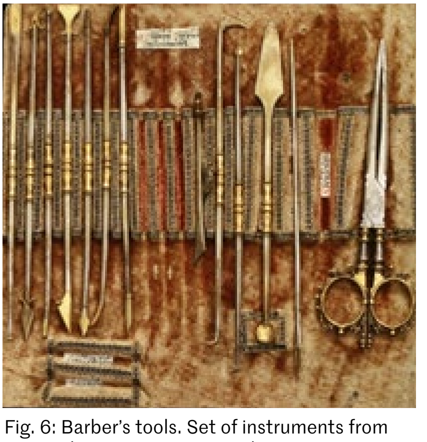

Fig. 6: Barber’s tools. Set of instruments from the Pomeranian art cabinet, commissioned by Philip Hainhofer, Augsburg, early 17th century.

marking, the materialized shape of an all-equalizing force,[27] but for the same reason, shaving implied the most subtle control over the body, a cultural achievement represented by the countless blades serving as grave goods to express the dead's purity and nobility, as well as by the high esteem for the profession of the barber in former times: Because of their precise tools and manual training, they often served as surgeons, e. g. in ophthalmological operations against cataract or by offering bloodletting. Fearless, quick and able operations are imperative for hygiene and to minimize pain or loss of blood.

Second, with progress in optical lenses the use of improved light microscopes also demands extremely thin and transparent objects, thus: sharpest blades for their production. Razor blades are mounted into special appliances for cutting slices of tissue as thin as 100 micrometers, as in Cummings' cylindrical retainer from 1774 that looked like a coffee mill.[28] Allegedly, the term "microtome" was later given to this invention by German physician Wilhelm His who was called to Leipzig in 1872, i.e. a few years after Braune's installation as a professor for anatomy. Even the minutest dissection destroys intact spatial, spherical and sensitive structures, and makes some elements visible only by taking away others, like in an archeological dig. The "obscure band" that, according to French biologist Georges Cuvier, connects the invisible processes of organic life, requires all kinds of preparation and optical media to capture and produce its particular aspects, moments, and details.[29]

A few years before Braune's Atlas appeared German architect Gottfried Semper, while strolling the London World Fair of 1851, speculated that industrial methods would revolutionize the world more that any other invention of his era because modern steam-engine saws "would pass through granite as if it were chalk".[30] But when it comes to the very seams of life, the contact zone between nature and image remains a difficult, often violent transition, made possible only through a diligent work and the use of various instruments, mobilizing all kinds of techniques from freezing, coloring and staining to gluing and varnishing, abrading and polishing, just like in early photography. The fundamental problems of representation connected with the pictorial translation of anatomies cannot be put aside so that in the end, even with the aid of the finest instruments and procedures, tissues or membranes can only be comprehended in a graphically enhanced version, represented by distinct lines or through hatchings.[31]

Likewise, the graphical clarity in Braune's atlas is made possible only by a special treatment of the body; by the fidelity of

27 Testing the sharpness of blades could even be a punishment of convicts, e.g. in 16th century Japan (kind information by Felix Jäger).

28 The history of the microtome has been particularly researched by Bracegirdle 987; for the role of compounds see Schickore 2007; Fiorentini 2013, pp. 379–394.

29 Cuvier 1800, p. 1

30 „der härteste Porphyr und Granit schneidet sich wie Kreide, polirt sich wie Wachs, das Elfenbein wird weich gemacht und in Formen gedrückt" (Semper 1852, p. 9).

31 For the impossibility to depict cellular membranes see e.g. Bruhn 2011.

the cut; and by some manual rectifications with a razor, as Braune admits in his book. While the lithograph requires a perfectly even surface (which relates it to a longer tradition of cutting and grinding), the section of the frozen body is slightly uneven or molded and can thus be traced and transferred on paper like from an ancient epigraph.[32] Moreover, the depiction of the divided organs regains volume and plasticity by the subsequent use of colors and shadowing that reanimate the pale tissue of the cadaver.

This detail is also relevant in terms of artistic practices. A cut leaves edges or margins behind that fold or tauten (like Lucio Fontana's canvases hit by a knife) or may begin to split and bleed. These margins may thus need further treatment or special forms of documentation, and like in Braune's case, require a certain knowledge and pre-planning concerning the structures not to be destroyed, which again corresponds to the complex measures necessary to cut through solid objects (or even entire buildings, like in the works of US-artist Gordon Matta-Clark). Such manoeuvres are "strokes" in a literal sense, i. e. lines revealed by the blade and at the same time replaced by emptiness; the German language would offer the term *reißen* for this effect which means both tearing and drawing.[33]

Artistic Limitations, or: Looking through the great glass

As already implied, cross sections show some surprising connections to the notion of a glass pane which in the case of microscopy can even be a concrete relation between blades, slides and lenses. Industrial plate glass, essential for medical and scientific progress and itself a solid but hardly visible medium, is a somewhat underestimated material, along with gum (or gummi). It became available in larger quantities only as early as in the 17th century but soon turned into one of the two most important means of isolation. In Braune's era Gottfried Semper not only marveled at the technical omnipotence of vulcanized rubber introduced by Charles Goodyear but also admired the excessive use of flat glass in the London exhibition hall therefore called "Crystal Palace". Homes or shop windows were now equipped with windowpanes of growing sizes.

Glass also turned out to be a material to cover and protect paintings, or to build box-like transparent cases or cabinets. If hermetically sealed, they could even be filled e. g. with liquids and used as aquaria containing living fish.[34] As a transparent, yet impermeable medium, it seemed to turn Leon Battista Alberti's Renaissance metaphor of the picture as a window into a concrete filter that allows for any kind of theatrical perspection, by separating one milieu from the other (like water from air) in a strictly frontal, vertical way like in a cross section. It placed a "pane of distinction" between one world and another, to play with the language of general system theory.

32 On the role of lithography for medicine see Lauer 2013.

33 Chichester 2018

34 Harter 2014

Walter Benjamin who had extensively studied the shop windows of modern Paris did not share the esoteric fascination for glass and crystalline forms common among contemporary artists and writers, in particular Paul Scheerbart's writings on glass architecture. In Benjamin's eyes things made of glass were as transparent as they were empty, without any secret or transcendence. Glass had been a symbol of secrecy for centuries, as in fortune telling, or of the microcosmic inclusion of the world in the alchemical flask. Through industrial fabrication, it was now capable of replacing spherical containers as used in chemistry and physics. In the long run, large windowpanes became a new means of total observation, be it in factories, laboratories, or police stations. 19th century research institutes for marine zoology or the observations of underwater life (fig. 7) would be unthinkable without this new material, and its essential role for modern life, science and technology, often "overlooked" in a literal sense, still deserves further study.[35]

Such materials are also important in terms of a longer visual history, because a work like Braune's Topographical Atlas seems familiar only because of its particular aftermath. A short commentary in the Heidelberg University Library rightly states that Braune's "body-cuts may count as prestage of computerized tomography."[36] However, in 1872 there is no such thing as motion pictures or radiology. Cross sections, stratigraphies, as well as time-lines or charts had to be invented first; they demanded tools, determination, and creativity. As a direct consequence of Braune's quasi-stratigraphical access, the body needed to be cut though more than once in order to obtain a complete topographical "image".[37]

This body image still remains an interpolation or summation of many individual layers even if represented in a model or in animated pictures. These layers do have a visible size or "resolution" that inspired British-born artist Marilène Oliver already in 2001 to create a series of columns, made of plexiglas with silk screen prints of the full MRI scan of patients. Stacked on top of each other like a life-size column they seem to preserve the body like a three-dimensional shadow.[38]

The *Atlas of topographical anatomy after plane sections of frozen bodies* follows an analytical impulse that dominated many other contemporary attempts of measuring, sampling and scanning the world, be it in the natural sciences, in anthropology and criminology or in the fields of chrono-photography and photo-sculpture. But Braune has also been taken literally a hundred years later, by directly repeating his work with greater accuracy. The Visible

35 Landbrecht, Straub 2018

36 „Die so entstandenen Körperschnitte können als Vorstufe der Computertomographie und Magnetresonanztomographie gelten." (Heidelberg University Library 2013).

37 The sequence shows the body from head to feet. During the 1980s, with the introduction of electronic imaging, direction has changed. The scanning procedure now commences with the feet.

38 Part of the series Family portrait (Galerie Hermann & Wagner Berlin, 2001), see Leismann 2006, p. 72 f.; also cf. Ecker, Kummer 2014

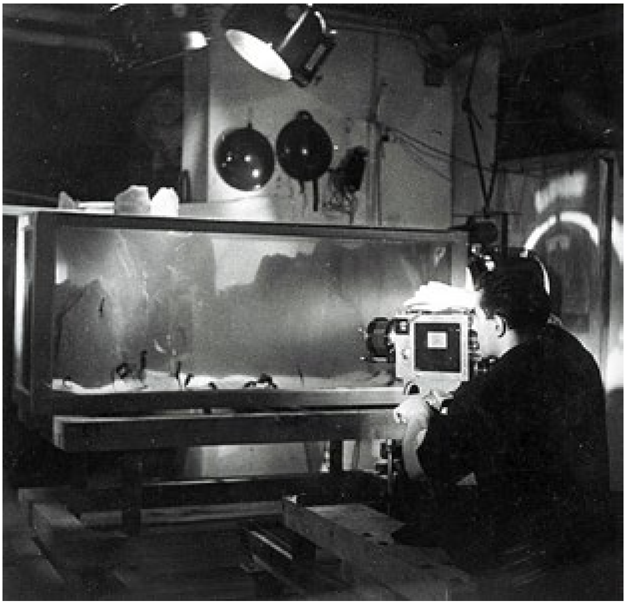

Fig. 7: André Raymond: Jean Painlevé in his studio (1931).

Human Project, initiated by the US-American National Library of Medicine, was to create "complete, anatomically detailed, three-dimensional representations of the normal male and female human bodies"[39] by dividing the frozen cadavers of two corpses into more than 1800 ultrathin slices that would be digitized to create a complete virtual vision of the human anatomy. The data set was made publicly accessible in 1994–95 and resembled the series of Braune's axial sections in many respects, also betraying some unexpected topographical details. However, their production has caused considerable concerns about the way the fatally ill patients were convinced to act as "organ donators", and the project's blending or short circuit of physical and virtual tomography has induced scholars (notably Lisa Cartwright and Catherine Waldby) to discuss its overall ideology.[40]

Although the term "tomography" still implies a kind of vision based on sections and slices, the metaphor of cutting has migrated to other instruments; it is now also used for surgical treatments on the basis of laser beams or electromagnetic waves. At the same time, due to the considerable turn in technology, cross section is transformed into a non-invasive diagnosis and therapy and an examination of the interior without damaging its vital functions: a vision that tends to make itself invisible, a stealth observation that seems to provide non-destructive images instead of deadly cuts. In the context

39 Visible Human Project 2014

40 Cartwright 1998; Waldby 2000; Reiche 2014

of such developments, the analysis of Braune's work may demonstrate how forms can unfold their meaning – or adopt new ones – even through their unexpected iconological afterlife.

Whenever new media promise to touch the boundaries of the visible world, e. g. by introducing forms of interactive visualization or digitally augmented vision, certain morphological structures or fluid matter remain unrepresentable in a monitor projection. In order to demonstrate the potential of VR instruments in a medical context, US computer giant Microsoft used conventional anatomic drawings of the human heart to underline the quasi-tactile qualities of its so-called Hololens, first presented in January 2015 (fig. 8). Once again it is the edges, margins, seams of the tomographic section on the monitor that imply the most complex information but escape the general attention. This is partly due to a prevailing discourse of space, depth or "3D". The words promise a manual tangibility that is often implied but de facto suppressed in stereoscopic vision. It is also commonly expressed by touching the pane of a window or an aquarium, in a vain attempt to enter the life behind.

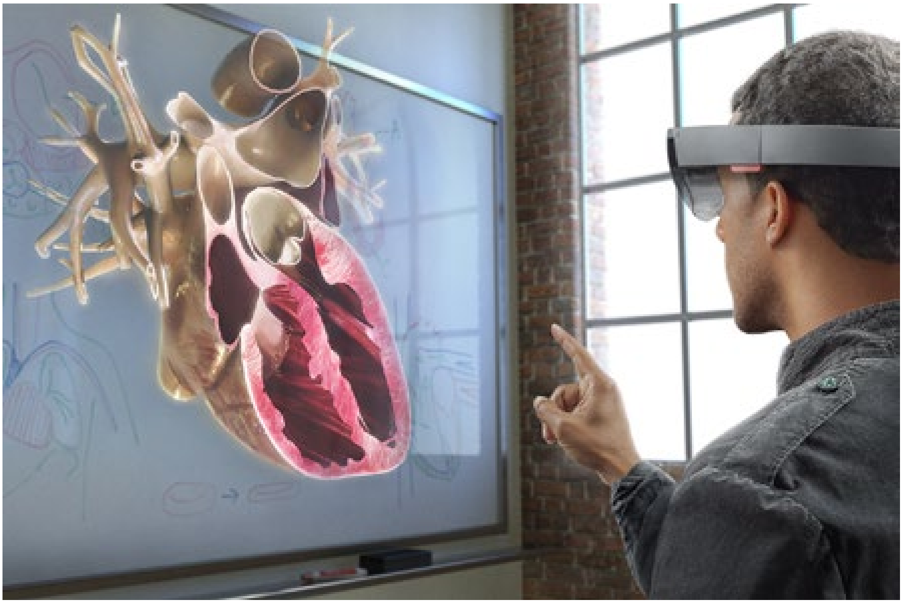

Fig. 8: Advertising image for 3D visualizations in heart surgery, using the Microsoft "Hololens", 2015.

Agricola, G.: De re metallica libri XII. Basel 1556

Arons, W. (transl./ed.): When Midwifery Became the Male Physician's Province: The Sixteenth Century Handbook "The Rose Garden for Pregnant Women and Midwives" (=Eucharius Rößlin: Der swangern Frauwen und Hebammen Rosegarten). Jefferson, NC 1994

Bracegirdle, B.: A History of Microtechnique. The Evolution of the Microtome and the Development of Tissue Preparation (2nd ed). Lincolnwood, Ill 1987

Braune, W.C.: Topographisch-anatomischer Atlas: nach Durchschnitten an gefrornen Cadavern. Leipzig 1867–1872, p. 1. English edition London 1877

British Medical Journal: Obituary: Professor Braune. British Medical Journal 7 May, 1892. 1(1636) p. 976

Bruhn, M.: Life lines. An art history of biological research around 1800. In: Studies in History and Philosophy of Science, Part C, 42, 2011, Issue 4: Cultures of seeing embryos, pp. 368–380

Caillois, R.: L'Écriture des pierres. Genève 1970. engl. The Writing of Stones. University of Virginia Press, 1985

Carlino, A. (ed.): Paper Bodies. A Catalogue of Anatomical Fugitive Sheets. Medical History, Suppl. 19, 1999

Cartwright, L.: A Cultural Anatomy of the Visible Human Project. In: Treichler, P.A.; Cartwright, L.; Penley, C. (eds.): The Visible Woman: Imaging Technologies, Gender and Science. New York, NY 1998

Chichester, K.L.: Von Tupfen, Rissen und Fäden. Präzision als verkörperte Praxis in der Frühen Neuzeit. In: Bruhn, M.; Hillnhütter, S. (eds.): Bilder der Präzision. Praktiken der Verfeinerung in Technik, Kunst und Wissenschaft. Berlin 2018. pp. 135–149, 136 ff.

Choulant, L.: History and bibliography of anatomic illustration (Rev. ed.) New York 1962 [German ed. 1852]

Cuvier, G.: Leçons d'anatomie comparée. Vol. 1, Paris 1800

Dackerman, S.: Prints and the Pursuit of Knowledge in Early Modern Europe. Exh. cat. Harvard Art Museums 2011/Block Museum of Art 2012. Cambridge 2011

Daston, L.; Galison, P.: Objectivity (3rd print). New York 2008

Didi-Huberman, G.: Ouvrir Vénus. Nudité, rêve, cruauté. Paris 1999

Diepgen, P.: Die Geschichte der Medizin 2.2. Berlin, Leipzig 1955

Doll, N.; Bredekamp, H.; Schäffner, W.: +ultra. knowledge & gestaltung. Exh. cat. Leipzig 2017

Donegan, J. B.: Women and Men Midwives: Medicine, Morality, and Misogyny in Early America. Westport, CN 1978

Ecker, B.; Kummer, R. (eds.): Lens-Based Sculpture. The Transformation of Sculpture Through Photography, Exh. cat. Akademie der Künste, Berlin / Kunstmuseum Liechtenstein, Vaduz, Berlin 2014

Ehrenreich, B.; English, D.: Witches, Midwives, & Nurses: A History of Women Healers (2nd ed). New York 2010

Estienne, C.: De dissectione partium corporis humani libri tres. Paris 1545

Fiorentini, E.: Induction of Visibility. Reflections on Histological Slides, Drawing Visual Hypotheses, and Aesthetic-Epistemic Actions. in: History and Philosophy of the Life Sciences 2013, 35(3) (Special Issue: Microscope Slides: Reassessing a Neglected Historical Ressource, guest ed.: Ilana Löwy)

French, R.: Dissection and Vivisection in the European Renaissance. Aldershot 1999

Goldschmid, E.: Entwicklung und Bibliographie der pathologisch-anatomischen Abbildung. Leipzig 1925

Harter, U: Aquaria in Kunst, Literatur & Wissenschaft. Köln 2014

Heidelberg University Library: „Anatomie in Heidelberg". Virtual exhibition project, 2013, www.ub.uni-heidelberg.de/allg/benutzung/bereiche/handschriften/anatomie2013/exponate/sektion5/V_25.html (accessed on 5 / 2015)

Helm, J.; Stukenbrock, K. (eds.): Anatomie. Sektionen einer medizinischen Wissenschaft im 18. Jahrhundert. Stuttgart 2003

Herrlinger, R.; Putscher, M.: Geschichte der medizinischen Abbildung. 2 vols. München 1967 / 1972

Hoffmann, C.: Schneiden und Schreiben. Das Sektionsprotokoll in der Pathologie um 1900. in: idem (ed.): Daten Sichern. Schreiben und Zeichnen als Verfahren der Aufzeichnung. Zürich, Berlin 2008

Hoffmann, C.; Berz, P. (eds.): Über Schall: Ernst Machs und Peter Salchers Geschoßfotografien" Göttingen 2001

Jordanova, L.: Sexual Visions. Images of Gender in Science and Medicine between the Eighteenth and Twentieth Centuries. Madison, WI 1989

Keller, S. B.: Sections and Views. Visual Representation in Eighteenth-Century Earthquake Studies. In: The British Journal for the History of Science 31, 1998, pp. 129–160

Kemp, M.; Wallace, M. (eds.): Spectacular Bodies. The Art and Science of the Human Body from Leonardo to Now. Exh. cat. Hayward Gallery London 2000. London 2000

Krause, W.: Christian Wilhelm Braune. In: Allgemeine Deutsche Biographie 47, Nachträge bis 1899: v. Bismarck-Bohlen – Dollfuß. Leipzig 1903

Landbrecht, C.; Straub, V.: Präzision ins Bild gesetzt. Der Reinraum als Showroom. In: Bruhn, M.; Hillnhütter, S. (eds.): Bilder der Präzision. Praktiken der Verfeinerung in Technik, Kunst und Wissenschaft. Berlin 2018. pp. 37–48

Lauer, N. J.: Der Kontrakt des Zeichners mit der Medizin. Ästhetik und Wissenschaft im Bildatlas Bourgery & Jacob. Würzburg 2013

Le Gendre, E. Q.: Anatomie chirurgicale homalographique. Paris 1858

Leismann, B. (ed.): Diagnose: Kunst. Die Medizin im Spiegel der zeitgenössischen Kunst. Exh. cat. Kunstmuseum Ahlen / ^Museum im Kulturspeicher Würzburg. Köln 2006

Lyons, A. S.; Petrucelli, R. J.: Medicine. An illustrated history. Repr. New York 1987

Mayer, A.: Wissenschaft vom Gehen. Die Erforschung der Bewegung im 19. Jahrhundert. Frankfurt am Main 2013

Merleau-Ponty, M.: The visible and the invisible. Followed by Working Notes (1964). Transl. Alphonso Lingis. Evanston 1968

Pirogov, N. I.: Anatome Topographica: Sectionibus Per Corpus Humanum Congelatum Triplici Directione Ductis Illustrata. St. Petersburg 1853

Ramelli, A.: Le diverse et artificiose machine. Paris 1588. Online at Lefèvre, W.; Popplow, M. (eds.): Machine Drawings. 2006–2009, http://dmd.mpiwg-berlin.mpg.de/ (accessed on 5 / 2015)

Reiche, C.: Digitale Körper, geschlechtlicher Raum. Das medizinisch Imaginäre des „Visible Human Project". Bielefeld 2014

Roberts, K. B., Tomlinson, J.D.W.: The Fabric of the Body. European Traditions of Anatomical Illustration. Oxford 1992

Rudwick, M. J. S.: The Emergence of a Visual Language for Geological Science, 1760–1840. In: History of Science 14, 1976

Schickore, J.: The Microscope and the Eye. A History of Reflections, 1740-1870. Chicago 2007

Schnapp, A.: The Discovery of the Past. The Origins of Archaeology. London 1996

Schulze, E.: Nulla dies sine linea. Universitärer Zeichenunterricht – eine problemgeschichtliche Studie. Stuttgart 2004

Semper, G.: Wissenschaft, Industrie und Kunst. Braunschweig 1852

Stafford, B. M.: Body Criticism. Imaging the Unseen in Enlightenment Art and Medicine (4th ed.) Cambridge 1994

Stafford, B. M.: Visual Analogy. Consciousness as the Art of Connecting. Cambridge 1999

Tomalino, M. U.: Una storia della Mineralogia. Roma 2011

Visible Human Project, http://www.nlm.nih.gov/research/visible/visible_human.html (accessed on 4/2014)

Waldby, C.: The Visible Human Project. Informatic Bodies and Posthuman Medicine. London 2000

Wunder, H.: Christian Wilhelm Braune. In: Ecce. Grimma 1892

Young, D.A.; Stearle, R.: The Bible, Rocks and Time: Geological Evidence for the Age of the Earth. Downers Grove, IL 2008

Image Sources

Fig. 1, 2, 5: National Library of Medicine, http://www.nlm.nih.gov/exhibition/historicalanatomies/home.html, [last check 10/2016].

Fig. 3: Online database “Machine Drawings”, ed. by W. Lefèvre and M. Popplow (2006-2009), http://dmd.mpiwg-berlin.mpg.de/ [5/2016].

Fig. 4: Author

Fig. 6: Copyright BPK / Kunstgewerbemuseum, Staatliche Museen Berlin / Helge Mund

Fig. 7: http://nightflight.com/wp-content/uploads/Jean-Painlevé-2.jpg

Fig. 8: https://blogs.windows.com/devices/2015/11/11/meet-the-award-recipients-of-the-first-microsoft-hololens-academic-research-grants/